PHYSICAL SCIENCE TEACHERS' PEDAGOGICAL KNOWLEDGE AND PRACTICES OF INQUIRY METHOD AT THREE SELECTED SENIOR SECONDARY SCHOOL LEVEL, KHOMAS EDUCATION REGION

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE

REQUIREMENTS FOR THE DEGREE

OF

MASTER OF EDUCATION (SCIENCE EDUCATION)

OF

THE UNIVERSITY OF NAMIBIA

BY

KRESTINA KAUPU SHIKONGO

STUDENT NUMBER: 9967079

Otocber 2022

MAIN SUPERVISOR: Prof. Hileni. M. Kapenda(UNAM)

CO–SUPERVISOR: Dr. H. U. Kandjeo-Marenga(UNAM)

APPROVAL PAGE

This research has been examined and approved as meeting the required standards for partial fulfilment of the degree of Master of Education requirements.

_____	_____
Internal Examiner	Date
_____	_____
Dean of Education Faculty	Date
_____	_____
External Examiner	Date

ABSTRACT

The main purpose of this study was to investigate the Physical Science teachers' pedagogical knowledge and practices of inquiry method at three selected senior secondary school level in the Khomas education region, Namibia. This study employed a qualitative, exploratory research design to explore the pedagogical knowledge and practice of Physical Science teachers regarding inquiry method. The targeted population for this study was 104 Physical Science teachers in 34 senior secondary schools in the Khomas education region.

Extreme case sampling method was used to select one secondary school among the top ten performing schools and two secondary schools that were at the bottom of the rank in the Khomas education region for the NSSCO Physical Science results of the year 2018. Purposive sampling was used to select two Physical Science teachers at each school on the basis that they have taught Physical Science for more than three years. Among the three participated schools, only one teacher from the second bottom performed school and two teachers from each of the other two schools agreed to take part in the study. Hence, the total sample of this study consisted of five (5) participants. Three research instruments were used namely: a questionnaire, observation checklists, and structured interviews/ schedule. After the collection of data and coding, qualitative thematic analysis method was employed to analyse and interpret the data.

The findings from this study revealed that all the participants used the inquiry method when teaching Physical Science, of which four (4) of the participants had received training on how to use the inquiry method during their teachers' training at the

university or college. However, only one participant was not trained to use the inquiry method. The findings from this study also revealed that Physical Science teachers needed further training on the inquiry method of teaching. The participants suggested that continuous professional development should focus on how to use inquiry method in large classes and with learners of different abilities. This study recommended that the Ministry of Education, Arts and Culture together with the National Institute for Educational Development (NIED) should provide workshop trainings to Physical Science teachers on the use of the inquiry method. Further research should also be conducted to investigate the impact of the inquiry method to learners' academic achievement in Physical Science.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS/ACRONYMS

B Ed.	Bachelor of Education
BETD	Basic Education Teachers' Diploma
DNEA	Directorate of National Examination and Assessment
GPK	General Pedagogical Knowledge
HOD	Head of Department
IAP	Inter – Academy Partnership
MoE	Ministry of Education
MoEAC	Ministry of Education Art and Culture
NIED	National Institute for Educational Development
NOS	Nature of Science
NRC	National Research Council
NSSCO	Namibia Senior Secondary Certificate Ordinary level
NUST	Namibia University of Science and Technology
PK	Pedagogical Knowledge
PCK	Pedagogical Content Knowledge
UNAM	University of Namibia

ACKNOWLEDGEMENT

Firstly, I would like to thank the Almighty God for giving me courage, faith and strength during the course of my studies. I would also like to express my profound gratitude and appreciation to the following people who assisted and supported me during my research.

Prof Hileni M. Kapenda, my main supervisor, for guiding and supporting me tirelessly throughout this study. Dr Hedwig Kandjeo – Marenga, my co–supervisor; your professional support and advice helped me a lot and Mr Ashton Kufa for editing and proofreading the thesis.

I would also like to thank the principals of participated schools and Physical Science teachers at all the three schools, without whom this research would not be completed. Furthermore, my deepest appreciation goes to my classmates Amanda Eisses, Vicky Verner and Ndatala Nghaamwa for encouraging me to work hard. I cannot forget to appreciate Mrs Eunice Limwena for motivating me to continue with my studies no matter the challenges I went through.

My heartfelt gratitude goes to my parents for keeping me in their prayers during the course of my studies. To my loving husband, Mr Iilonga, and our children Hanganeni, Simaneka and Hambelela. Thank you for your unwavering patience and understanding, without which I would not found strength to complete this study.

May the Almighty God bless you all!

DEDICATION

This study is dedicated to my late sister Margret Shikongo and my children Hanganeni, Simaneka and Hambelela.

DECLARATIONS

I, Krestina Kaupu Shikongo, declare that this study is a true reflection of research conducted, except where indicated by a reference. This research or any part thereof has not been submitted for any other degree or professional qualification. No part of this thesis may be reproduced, stored in any retrieval system, transmitted in any form, or by means (e.g., electronic, mechanical, photocopying, regarding, or otherwise) without the author's prior permission, the University of Namibia on that behalf.

I, Krestina Kaupu Shikongo, grant The University of Namibia the right to reproduce this thesis in whole or in part, any manner or format, which The University of Namibia may deem fit.

Krestina Kaupu Shikongo  October 2022

Name of student **Signature** **Date**

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Scientific knowledge and skills acquired through science education is cornerstone for both economic and social sustainability in every country (Inter-Academy Partnership (IAP), 2010). The overall aim of the Physical Science syllabus of the Namibia Senior Secondary Certificate Ordinary level (NSSCO) is "to equip learners with the necessary knowledge, skills and attitudes that will enable them to enter tertiary education or the world of work" (Ministry of Education (MoE), 2009, p. 8). Furthermore, the NSSCO Physical Science syllabus aims to increase learners' knowledge and understanding of the physical and biological world of which they are part of; thus, enhancing learners' critical thinking, problem solving and investigating skills, as well as their ability to interpret data and apply knowledge to practical activities (MoE, 2009). The major goal of science education is to promote scientific literacy through fostering learners' intellectual competencies in the form of independent learning, problem solving, decision-making and critical thinking (National Research Council (NRC), 2011). Thus, Magnusson et al. (1999) as cited in Bozkurt and Kaya (2008) highlighted the need for Physical Science teachers to have a strong pedagogical knowledge in order to be efficient in teaching Physical Science to learners.

According to Shulman (1987), pedagogical knowledge is one of the categories in the knowledge base which entail instructional practices, teaching strategies, learners'

roles and classroom management. Similarly, Koehler, Mishra and Cain (2013) assert that pedagogical knowledge (PK) consists of teachers' deep knowledge regarding processes and practices of teaching and learning. PK comprises of a variety of teaching and learning activities ranging from teachers' preparation and decisions on the kind of teaching strategies to employ as well as managing and creating a conducive learning environment and planning for learners' formative assessments. Furthermore, Koehler, Mishra and Cain (2013) posit that "a teacher with deep pedagogical knowledge understands how students construct their knowledge and acquire skills and how they develop habits of mind and positive dispositions toward learning" (p. 97).

Furthermore, Mamba and Putsoa (2018) as cited in Lumpe (2008) proposed that, "in order for science teachers to adequately prepare learners to participate effectively and acquire investigation skills, they should be knowledgeable about the best classroom practices that result in the successful achievement of aims of science education" (p. 85). In other words, this may suggest that employment of teaching strategies that place less emphasis on recall and regurgitation of facts should lean more on teaching science for understanding and application.

Additionally, Jeffery, Marshall and Sort (2012) hold that the importance of understanding relationships between teacher preparation, pedagogy and learners' achievement has motivated a new line of research thoughts that focuses on teacher knowledge. Thus, Bell et al. (2001) maintain that professional development training should provide activities where teachers explore their knowledge of inquiry and their involvement in the inquiry process by generating questions, as well as designing and

conducting investigations, and practical demonstrations in the laboratory. Such investigations, coupled with numerous classroom activities need to model pedagogical techniques that present opportunities for teachers to expand own knowledge on how to teach and acquire skills necessary for teaching inquiry in science classrooms. More so, teachers' professional development programmes should aim at promoting inquiry skills and enhancing teachers' pedagogical knowledge and skills, thereby actively engaging teachers in a variety of instructional strategies that will accommodate learners with different learning abilities in the science classroom.

A study conducted by Ramnarain and Schuster (2014) argued that "to teach science effectively, one requires an integration of different types of knowledge, including knowledge of content, pedagogies, science teaching methods, inquiry and how to apply these when teaching specific topics to specific groups of learners" (p. 145). The above implies that teachers' sound pedagogical knowledge enables them to incorporate different kinds of knowledge in selecting appropriate teaching strategies and planning for specific content, and context for learners with different learning abilities. Previous studies on teachers' knowledge have demonstrated that effective teachers technically manage instruction and generate the greatest opportunity for learners (Onojerena & Eromosele, 2018).

Several studies have been carried out in Africa and other parts of the world to investigate teachers' knowledge of different subjects, as well as their PK. Mamba and Putsoa (2018) found that secondary school science teachers' knowledge and their teaching strategies have an impact on their classroom practices as well as their

learners' achievements in general. In addition to that, Johnson et al., (2007) as cited in Mamba and Putsoa (2018) stated that "learners of teachers employing effective teaching strategies scored significantly higher in assessments than those whose teachers employed ineffective instructional strategies" (p. 16).

Moreover, Kanyongo and Brown (2013) in their research on the relationship between teachers' pedagogical strategies and their content knowledge of Mathematics found out that the Mathematics teachers' classroom practices were related to their knowledge. Kanyongo (2013) also revealed that teachers' pedagogical strategies were directly proportional to their Mathematics content knowledge. Furthermore, evidence from the study above proved that teachers' pedagogical knowledge had an effect on their choice of teaching strategies and the way they presented the subject content to learners. From this background, the researcher aims to investigate PK for Physical Science teachers and how they translate the subject content using the inquiry method.

An investigation into practices that helped learners improve their performance in Physical Science at two schools in Omusati region by Haimbangu (2018) found that the classroom environment also assisted learners in performing well academically. The classroom environment is considered to be the best practice because it entails the most crucial component of the learning environment. Therefore, teachers should use their PK to manage classroom procedures and learners' behaviour to ensure effective utilisation of time on teaching and learning activities as learners take responsibility for their own learning. It remains the teachers' responsibility to apply their PK and skills to establish a culture of learning among learners and respecting one another

enhances learners' responsibility towards their study and thus, respecting themselves and other too. These practices enable learners to focus more on their studies and in the process, it helps them to perform well academically.

Furthermore, Haimbangu (2018) noted that Physical Science teachers who created an environment of respect and rapport established a culture for learning, managed classroom procedures, managed learners' behaviour, organised the physical space and influenced their learners' utmost performance. Guerriero (2013) provided a list of factors that could determine the quality of a teacher in relation to class size, years of experience as well as the type of qualification and their pedagogical knowledge. Guerriero (2013) further asserts that the PK of a teacher is one of the less studied indicators of the mentioned qualities of teachers.

A study on Grade 12 Mathematics teachers' subject and pedagogical content knowledge (PCK) in the Khomas education region by Kandjinga (2018) reported that Grade 12 Mathematics teachers had a satisfactory subject content knowledge but lacked sufficient PCK. Similarly, a study conducted by Liswaniso (2019) on teaching of Biology and Physical Science practical work in Senior Secondary schools in the Zambezi region, shows that Biology and Physical Science teachers rarely taught practical work and if taught, it was not based on learning objectives as outlined in syllabi.

As per literature that was reviewed, there seems to be little research conducted on Physical Science teachers' PK in relation to the inquiry method in science education in Namibia. Consequently, this study seeks to fill the resulting gap in the academic literature.

1.2 Statement of the Problem

The Khomas education region is one of the fourteen education regions in Namibia where learners are underperforming in Physical Science in the national examinations at NSSCO level (Directorate of National Examination and Assessment (DNEA), 2014; 2015; 2016; 2017; 2018). An analysis of Physical Science results in the national examinations of the Namibia Senior Secondary Certificate Ordinary (NSSCO) for the years 2014 to 2018 reveals that the overall percentage of quality symbols (symbols from A* to D) obtained was less than 50% respectively (DNEA, 2014; 2015; 2016; 2017; 2018). See table below:

Table 1 Statistical analysis of the NSSCO Physical Science 2014-2018 results in the Khomas region

Year of examination	**Percentage (%) of quality symbols (A* to – D)**
2014	38.68
2015	48.84
2016	37.16
2017	47.45
2018	46.74

Source: (DNEA, 2014; 2015; 2016; 2017; 2018)

According to the NSSCO Physical Science examiner's report, most learners performed poorly in questions requiring the utilisation of practical and investigation skills (DNEA, 2017; 2018). Mamba and Putsoa (2018) warn that "the low number of schools with candidates obtaining credit passes is a cause for concern because

examination results tend to be equated with the quality of education received by learners" (p. 74). In the same vein, Ramnarain and Schuster (2014) assert that teachers need not have good subject content knowledge only but also require appropriate PK, in other words, know how to translate specific subject content in using appropriate teaching approaches for specific content topics and to groups of learners.

By drawing on the concept of inquiry method, Hussain, Azeem and Shakoor (2011) concluded that learners who were taught by the guided, unguided and a combination of scientific inquiry methods of teaching applied the concepts of physics to real life situations better when compared to those taught by means of traditional lecturing methods of teaching Physics. Furthermore, in a study on the effect of the inquiry method of teaching on learners' achievement in Algebra, a group of learners who were taught by this method performed significantly higher than the group of learners taught the same content using the expository method (Kurumeh, Jimin & Mohammed, 2012).

Most research also only looked at pre-service with little effort made to understand the in-service teachers' technological pedagogical content knowledge. Therefore, a knowledge gap exists on pedagogical knowledge of secondary school science teachers. This study therefore investigated Physical Science teachers' pedagogical knowledge and practices of inquiry at secondary school level in the Khomas education region in Namibia. Considering the identified poor performance in Physical Science at Grade 12 Senior Secondary level, more specifically in the Khomas education region, this study therefore investigated Physical Science

teachers' pedagogical knowledge and practices of inquiry at secondary school level in the Khomas education region in Namibia.

1.3 Research Questions

The study was guided by the following research questions.

1. What are Physical Science teachers' perceptions about pedagogical knowledge of inquiry method to teach Ordinary level?
2. How do Physical Science teachers practice their pedagogical knowledge through the inquiry method to teach Ordinary level?
3. What are the challenges Physical Science teachers face as they use the inquiry method?

1.4 Significance of the Study

This study contributes to the current understanding of Physical Science teachers' PK and practices of the inquiry method at secondary level in the Khomas region in Namibia. Findings from the study could inform Physical Science teachers regarding PK and inquiry method as being practised by teachers. Furthermore, findings of the study inform Physical Science teachers of the challenges they faced using the inquiry method.

The Ministry of Education, Art and Culture (MoEAC), policy makers, National Institute for Educational Development (NIED), Faculty of Education at universities, as well as representatives from teacher training institutions and curriculum developers benefit from the findings of the study as they are informed regarding PK and the inquiry skills that Physical Science teachers need to acquire when teaching

practical work. Physical Science teachers become aware of challenges they face in using practical or investigation skills by applying the inquiry method. It enables them to improve the standard of teachers' training and equip them with all the necessary inquiry skills required to teach inquiry to learners, in other words, providing all the necessary assistance and service on time to enable teachers to practice the inquiry method. Findings from this study might also inform the MoEAC, NIED and curriculum planners/developers of the need to provide in-service training and workshops in order to keep Physical Science teachers well updated with the curriculum requirements.

1.5 Limitations of the Study

Initially, the study was to be conducted at four selected secondary schools in the Khomas education region. However, the principal at one of the chosen schools declined the request to carry out research at the school. Hence, the study was only conducted at three secondary schools. Secondly, at one school only one teacher agreed to take part in the study. As a result, a total of five participants instead of eight took part in the study. The small sample therefore limited collection of more data and as such few participants took part than intended for the study. Furthermore, the findings of this study depended mainly on the willingness and openness of participants to answer the research questions.

1.6 Delimitations of the Study

This study focused on investigating the PK and practice of the inquiry method in teaching Physical Science at secondary school level in the Khomas education region only. The study was restricted to Physical Science teachers at three selected

secondary schools in the Khomas education region; one top performing and two lower performing schools as per the 2018 Physical Science results of the NSSCO National examinations. Therefore, findings from this study cannot be generalised to other secondary schools in the Khomas education region.

1.7 Definitions of Terminologies

Pedagogical knowledge: In this study the term PK refers to a teacher's knowledge of general instruction and "broad principles and strategies of classroom management, learner assessment and the organisation of subject matter knowledge" (Brodie & Sanni, 2014).

Pedagogy: In this study, pedagogy refers to the collected practices, processes, strategies, procedures and methods of teaching and learning. It also includes the knowledge of the aims of instruction, assessment and student learning (Jimoyiannis, 2010).

Inquiry method: In this study, the inquiry method refers to the method of teaching involving learners in developing investigative questions, designing investigation procedures, collecting and interpreting data, drawing conclusions from the data and communicating their findings (Mkimbili, Tiplic & Ødegaard, 2017).

Inquiry: Inquiry is defined as the search for truth, information or knowledge by questioning (Hussain, Azeem & Shakoor, 2011). In this study inquiry refers to the process involving the use of scientific skills to find a solution to a problem or to answer a question.

1.8 Summary

This chapter covered information regarding the background of the study, statement of the problem, research questions and the significance of the study. Furthermore, in this chapter a discussion of the limitations and the delimitations of the study, as well as definitions of the terms employed are presented. The next chapter (Chapter Two) discusses the theoretical framework and a review of the literature related to the research focus.

CHAPTER TWO

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Introduction

In this chapter, the researcher presents the theoretical framework on which this study is based as well as a review of the literature concerning the Pedagogical Knowledge (PK) and practice of the inquiry method in teaching Physical Science at secondary school level in Namibia. Furthermore, literature is reviewed and presented on the inquiry teaching method; knowledge required to utilise an inquiry method; as well as challenges faced by Physical Science teachers when implementing the inquiry method.

2.2 Theoretical Framework

Several theories exist that are associated with teaching and learning processes. With regards to this study, the theoretical framework guiding and explaining teachers' PK and practices of an inquiry method is based on the Teachers' Knowledge Framework, called Pedagogical Knowledge (PK) by Shulman (1987). There are seven categories of knowledge as identified by Shulman (1987), namely:

- Content knowledge: with special reference to subject content knowledge of the teacher;
- General pedagogical knowledge: with special reference to those broad principles and strategies of classroom management and organisation that appear to transcend subject matter;

- Curriculum knowledge: with particular grasp of the materials and programmes that serve as 'tools of the trade' for teachers;
- Pedagogical content knowledge: that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding;
- Knowledge of learners and their characteristics: with special reference to understanding how they learn and knowing their abilities and their needs;
- Knowledge of educational contexts: ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures; and
- Knowledge of educational ends, purposes, and values, and their philosophical and historical grounds (p. 8).

Thus, from Shulman (1987) categories of knowledge, general pedagogical knowledge (GPK) and pedagogical content knowledge (PCK) form the backbone of this study. The first category (GPK) forms the basis of this study because it has to do with the general knowledge of the teachers on choosing the appropriate teaching method to be employed in teaching a specific topic or in attaining specific learning objective(s). Meanwhile, the second category (PCK) links the teachers' subject content knowledge with the teaching methods employed. Furthermore, PCK has to do with the teachers' knowledge on how best teachers can present the subject content to learners in a way that they will understand the subject content better. In addition, PCK entails teachers' ability to assess learners' prior knowledge with the aim of finding learners' preconceptions and misconceptions about the topic of the lesson, in order to eliminate them as well as relate the subject content to real life situations.

Hence, teachers will be able to eliminate the common misconceptions and thus allow learners to relate the subject content to real life situations.

Pedagogical knowledge is defined as "deep knowledge about processes and practices or methods of teaching and learning and encompasses overall educational purposes values and aims" (Koehler & Mishra, 2008, p. 14). Similarly, Guerriero (2013) defines pedagogical knowledge "as the specialised knowledge of teachers for creating effective teaching and learning environments for all students" (p. 16). Therefore, this study employed the definitions of PK by Guerriero (2013) and Koehler and Mishra (2008) because both emphasised on the roles and responsibilities of teachers in a classroom setting that involve planning and preparation of teaching and learning activities, managing the classroom and assessing learners. Therefore, this study combined the Shulman (1987) two categories of knowledge namely GPK and PCK as the basis for research.

On the other hand, Grosman and Richert (1988) as cited in Ben-Peretz and Shachar (2012) define teachers' knowledge as "a body of professional knowledge that encompasses both knowledge of general pedagogical principles, skills and knowledge of the subject matter to be taught" (p. 54). Thus, Jimoyiannis (2010) describes pedagogy (P) "as the collected practices, processes, strategies, procedures and methods of teaching and learning. In light of the above, pedagogy also includes the knowledge about aims of instruction, assessment and student learning" (p. 599). Pedagogical Content Knowledge (PCK) forms the basis of this study because it entails teachers' knowledge and skills on choosing the appropriate content for a

specific learning objective and designing the activities and tasks for assessment purposes based on the syllabi' competencies.

Pedagogical knowledge is also described as a teacher's knowledge of general instruction and broad principles and strategies of classroom management and the organisation of subject matter knowledge (Brodie & Sanni, 2014; Zeidler, 2002; Shulman, 1987). Additionally, Hughes (2005) states that "general pedagogical knowledge, such as learning theories, individual cognitive development and classroom management serve teachers across all subject areas with general pedagogical choices" (p. 279). In the same vein, Koehler, Mishra and Cain (2013) state that this basic form of knowledge applies to the understanding of the way in which learners learn, general classroom management skills, as well as lesson planning and learner assessment. PK also includes knowledge of techniques or instructional methods employed in the classroom, teaching learners of different abilities and using strategies in evaluating learners' understanding. Furthermore, PCK theory serves as a basis for this study as it involves teachers' knowledge and skills on preparing teaching and learning activities to accommodate all learners with different learning abilities, thus involving the ability to plan separate and different activities for above average learners, average learners and below average learners.

Similarly, Guerriero (2013) emphasises that investigating the knowledge of teachers involves an understanding of the way in which this knowledge functions in the teaching-learning process, more specifically, the ways in which they apply their knowledge in making decisions, for example, about designing lessons and learner assessment activities. It should however be noted that making good pedagogical

decisions depend on the quality of the pedagogical knowledge held by the teacher. Therefore, this study is supported by the view of Guerriero (2013), as the study aims to investigate how teachers apply their pedagogical knowledge in presenting lessons and transferring the subject content to learners using the inquiry method.

It has become clear that teachers make use of various types of knowledge when they plan for, and implement instruction. Halim, Abdullah and Meerah (2014) suggest different types of knowledge that teachers require to plan, design and conduct their teaching and learning activities:

- Knowledge of the subject matter: This implies that a teacher needs to know the content he or she is teaching and be able to relate the subject content to the world around the learners.
- Knowledge of teaching strategies: Teachers should use a variety of teaching approaches to teach different topics and their teaching methods should enhance learners' interest in science.
- Knowledge of concept representation: Teachers need to use appropriate diagrams and graphs to explain science concepts to the learners and they should use examples with which learners are familiar to help them understand science concepts.
- Knowledge of teaching context: Teachers should create a conducive environment for learning science and pay attention to students' reaction during class and adjust their approach to teaching and learners' needs.
- Knowledge of learner understanding: Teachers should realise learners' prior knowledge and know their learning difficulties of the subject before instruction.

- Knowledge of assessment: The teachers' tests should assess the learners' science learning and understanding of concepts. Teachers need to use a variety of key words in questions, such as *discussion* and *elaborate*, as well as asking learners to explain their answers to establish whether they comprehended the content (p. 230).

Science teachers should use various teachers' knowledge in planning, designing and conducting their instruction effectively in order to enhance the development of scientific skills among learners. Furthermore teachers need to know their learners' abilities and needs so that they are able to design appropriate assessment tools for the learners' mastery level.

The theoretical framework for this study incorporated the use of 5E Instructional Model as a method to support inquiry method. According to Bybee **(**2014), the method of inquiry can be more effective by incorporating the 5E instructional model. Furthermore, this model consists of five phases: engagement, exploration, explanation, elaboration and evaluation (Bybee, 2014; Çepni & Şahin 2012; Duran & Duran, 2004; Lin et al., 2014). Each phase of the 5E Instructional Model offers the main characteristics to help the teacher develop learning activities and guide learners as they learn Science (Lin et al., 2014). The 5E Instructional Model also informs this study as each of its phase entails the use scientific skills that learners are expected to practice during the inquiry method. Furthermore, the 5E Instructional Model, enable teachers to choose appropriate teaching and learning activities which may enhance learners' investigation skills and critical thinking. The development of such skills on

learners plays a crucial role on the attainment of the syllabi competencies and on their academic achievement.

A teacher with deep pedagogical knowledge understands how students construct knowledge and acquire skills, and how they develop habits of mind and positive dispositions toward learning. Content knowledge (CK) is teachers' knowledge about the subject matter to be learned or taught and PCK covers the core business of teaching, learning, curriculum, assessment and reporting, such as the conditions that promote learning and the links among curriculum, assessment and pedagogy. In addition, Pedagogical Knowledge (PK) is teachers' deep knowledge about processes and practices or methods of teaching and learning. PK encompass, among other factors, overall educational purposes, values and aims. This generic form of knowledge applies to understanding how students learn, general classroom management skills, and lesson planning and student assessment. It also includes knowledge about techniques or methods used in the classroom, the nature of the target audience and strategies for evaluating student understanding.

Both general (GPK) and PCK are interrelated in the sense that both entail PK, which highlighted the roles and skills of the teacher in the classroom setup during instructions. The term 'content' on PCK highlights the need of teachers' knowledge of the subject matter in relation to the teaching strategies. Therefore, these three categories by Shulman (1986) namely PK, GPK and PCK form the theory of the study.

2.3 Literature Review

2.3.1 The inquiry teaching method

The inquiry teaching method refers to the process of involving learners in developing questions for investigation, designing investigation procedures, collecting and interpreting data, drawing conclusions from the data and communicating the findings (Mkimbili, Tiplic & Ødegaard, 2017). The term inquiry is defined by Hussain, Azeem and Shakoor (2011) as a way of "seeking for truth, information or knowledge – seeking information by questioning" (p. 269). On the other hand, learner inquiry is defined as "a versatile activity that involves making observations, posing questions, examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of the learner's experimental evidence; using tools to gather, analyse and interpret data; proposing answers, explanation and predictions; and communicating the results" (Hussain, Azeem & Shakoor, 2011, p. 269). Furthermore, Akama (2015) and Aksela (2011) describe the inquiry method as a teaching and learning process in which learners take part in formulating questions whereby they investigate at a wider range and then construct new understanding and knowledge.

With reference to the definitions of inquiry and the inquiry method given by different authors above, it is evident that the inquiry method involve teachers' role as facilitators who provide the problem or ask questions and create the conducive learning environment whereby learners design investigation procedures and set questions that will guide their investigation and findings. Therefore, definitions of inquiry by Mkimbili, Tiplic and Ødegaard (2017) as well as Hussain, Azeem and Shakoor (2011) are relevant to this study, since both emphasised on the role of the

teachers in using their pedagogical knowledge to plan and design teaching and learning activities that foster active learners' involvement in the process of asking and answering questions, handling of apparatus, collecting and interpreting of data as well as drawing of conclusion and presenting findings.

Scientific inquiry is at the heart of Science teaching in which learners are engaged in the process of scientific research (Yang & Liu, 2016). Wilcox, Kruse and Clough (2015) stress that the distinction between teaching science simply through hands-on activities and teaching science through inquiry is the degree to which learners must engage mentally in designed learning activities. Ramnarain (2014), citing the Department of Basic Education (2011) points out that "in order for learners to competently engage in inquiry, they need to possess well developed investigative skills such as classifying, communicating, measuring, designing an investigation, drawing and evaluating conclusions, formulating models, hypothesising, identifying and controlling variables, inferring, observing and comparing, interpreting, predicting, problem-solving and reflective skills" (p. 181). In relation to this study, it is imperative that science teachers use their pedagogical knowledge to design teaching and learning activities that could enhance active learners' participation in order to develop scientific skills as prescribed in the syllabus. As per the basic competencies in Physical Science, teachers should therefore create the conducive environment in which learners are allowed to handle apparatus and be able to apply their scientific skills such as recording data; predicting results and explaining their findings.

Ssempala (2017) draws on the work of the National Research Council (NRC) (2000) which suggests that the essential features of classroom inquiry are:

- Learners are engaged by scientifically oriented questions;
- Learners give priority to evidence;
- Learners formulate explanations from evidence to address scientifically oriented questions;
- Learners evaluate their explanation in light of alternative explanation;
- Learners communicate and justify their proposed explanation (2017, p. 2).

According to NRC (2000) the suggested features of an inquiry classroom implies that through the inquiry method learners should be able to answer and ask scientific questions. Furthermore, learners in an inquiry classroom should be able to use scientific laws and principles (subject content) to answer scientific questions and explain their reasoning.

2.3.2 Levels of inquiry method

Researchers in science education have developed phases of inquiry that classify classroom inquiry into different levels, namely: structured, guided and open inquiry (Akama, 2015; Alake-Tuenter, 2012; Moore, 2009; Tsakeni, Vandeyar & Potgieter, 2009; Yang & Liu, 2018). To determine whether an instruction is structured, guided or an open inquiry, one must consider the level of learner and teacher involvement in each of the essential features of inquiry methods (Yang & Liu, 2018). The roles of the teacher in an inquiry lesson and the degree of involvement of the learners in teaching and learning activities determine the level of inquiry methods whether structured, guided or open.

2.3.2.1 Structured inquiry

In a structured inquiry, the teacher presents a question or a problem and procedures to be followed by learners to reach a conclusion (Moore, 2009; Pearly 2010). In this type of activity, learners investigate a problem presented by the teacher by utilising a prescribed procedure provided by the teacher (Lederman, 2007). Learners are often asked questions to make predictions regarding the outcome of the inquiry. Moore (2009) confirms that this level of inquiry provides opportunities for learners to develop their own inquiry skills such as analysing data and reaching their own evidence-based conclusions. In a structured inquiry teachers are required to use their PK to choose the appropriate question, problem and design procedures such that learners of different learning abilities are able to actively participate on the investigations and contribute their views to the conclusion.

2.3.2.2 Guided inquiry

In guided inquiry, teachers set a problem or ask question(s) and learners are expected to develop their own strategies to find a solution (Moore, 2009). Pearly (2010) maintains that learners explore and conduct research on their own, with some guidance by the teacher, based on the questions set. Lederman (2007) proposes that during this level of inquiry, learners have the opportunity to apply their analytical skills to support their own evidence-based conclusions to the question being investigated. Moore (2009) and Lederman (2007) posit that guided inquiry provides opportunities for learners to take more responsibility during the investigation, thus learners may have choices regarding procedures, materials, the organisation and analysis of data and conclusion. A guided inquiry require teachers to create a conducive learning environment whereby learners develop investigative skills as they

design procedures to find solutions to the problem at hand. Creating a conducive environment includes providing materials and apparatus required, selecting a suitable site in the school yard and giving learners enough time for investigations, presentations and explanation their findings and conclusion.

2.3.2.3 Open inquiry

According to Lederman (2007), in open inquiry, selection of problems, strategies and solutions problems are left open to learners. The objective is for learners to take full responsibility for all aspects of the investigation. These activities involve learners in formulating their own questions, developing procedures to answer their questions, collecting and analysing data and utilising evidence to reach their own conclusions of the investigation (Alake-Tuenter, 2012; Lederman, 2007; Moore, 2009; Yang & Liu, 2018). Jimoyiannis (2010) adds that learners require critical thinking skills and in-depth understanding of science concepts in seeking solutions to identified problem(s). Lederman (2007) emphasises that it is only with experience of all the levels and procedures of scientific inquiry that learners achieve the ultimate goal of becoming inquiry scientifically literate. In an open inquiry teachers are required facilitate and guide learners to choose the problem or question for investigation. Teachers play their role in supporting learners in all aspects including the designing procedures stage as well as providing all apparatus and materials required for the investigations.

Inquiry teaching is supposed to support learners in improving their understanding of the world around them and their knowledge of scientific inquiry (Aksela, 2017;

Grangeat, 2016; Harlen, 2011). It is, therefore, crucial that inquiry teaching should serve the following essential functions of:

- Constructing understandings of scientific concepts;
- Providing opportunities to use inquiry process skills;
- Contributing to the establishment of understandings about scientific inquiry and
- Providing opportunities to develop higher order thinking skills (Yang & Liu, 2016, p. 4).

When employing inquiry methods, teachers should aim to develop the understanding of science theories and principles, and this can be achieved by confronting learners with learning activities that involve the application of scientific laws and theories. Thus, Science teachers' PK should include the ability to provide learners with challenging questions that should enhance their thinking and problem solving skills.

Teaching by means of the inquiry should seek a more scientific and effective strategies in order to improve learners' understanding of scientific concepts. In particular, the emphasis should be on engaging learners in higher-order thinking tasks that can direct them to meaningful learning (Aksela, 2017). Therefore, inquiry teaching tasks need be designed to resemble a more real-world situation that will motivate learners to transfer their knowledge and skills. Furthermore, Science teachers need to be more creative thus they need design teaching learning activities such that they relate the subject content to real life situations.

Inquiry teaching and 5E instructional model

Bybee (2014) states that "each phase of a 5E Instructional Model has a specific function that contributes to the teacher's clear instruction and the students' formulating a better understanding of scientific and technological knowledge, attitudes and skills" (p. 13). Bybee (2014) further adds that the model would be employed to design an instructional sequence that would assist teachers in approaching instruction in a meaningful way that enhances student learning. The roles of the teacher in each phase of a 5E Instructional Model are linked to those in the inquiry method; hence, incorporating the model in an inquiry lesson enhances learners' development and understanding of scientific concepts.

2.3.3.1 Phase 1: Engagement

The goal of this phase is to capture the learners' attention and interest (Bybee, 2014). At the same time, the teacher's aim is to assess learners' prior knowledge and identify possible misconceptions regarding the concept (Dura & Duran, 2004). This learner-centred phase should be a motivational period that can create a desire to learn more about the upcoming topic (Duran & Duran, 2004) and ensure that learners are focused on a problem that involves the intended content and abilities of instruction (Bybee, 2014). Moreover, Çepni and Şahin (2012) point out that the engagement stage is a warm-up phase in which learners get ready to learn. It makes them aware of their own knowledge and queries about the concept.

The role of teachers in the engagement phase is to arouse learners' interest in the subject whereby teachers create a conducive environment by designing teaching and learning activities incorporated with questions, to assess learners' prior knowledge on the topic. Teachers should aim to capture learners' attention and motivate them to be focused on the topic to be discussed. It is therefore necessary at this phase to make use of their PCK to select the subject matter that attract learners to pay attention and have an interest on the topic under discussion. At the same time, teachers should also use this phase to identify misconceptions from learners by testing their prior knowledge on the topic. The engagement phase could be linked to the guided inquiry level since learners are asked questions on the topic to be learnt and are guided by assessing their prior knowledge and identifying misconceptions from their responses. Teachers' general pedagogical knowledge (GPK) of learners is applicable at this phase as teachers are required to identify learners' misconceptions and design teaching and learning activities.

2.3.3.2 Phase 2: Explore

According to Bybee (2014), exploration lessons provide concrete, hands-on experiences where students express their current conceptions and demonstrate their abilities as they try to clarify the confusing elements of the engagement phase. Learners are encouraged to test their own knowledge and apply process skills, such as observing, questioning, investigating, testing predictions, hypothesising and communicating with their peers (Çepni & Şahin, 2012).

The role of the teacher during the exploration phase is to initiate activities, describe appropriate background, provide adequate materials and equipment, counter any

misconceptions, while at the same time observe and guide learners as they clarify their understanding and begin reconstructing scientific concepts and developing their abilities (Bybee, 2014). At the exploration phase, teachers should have good sound GPK and PCK to be able to plan and design appropriate teaching and learning activities where learners will be actively involved in handling materials and apparatus to carry out investigations. The knowledge teaching method and subject content is also required for teachers to choose the best strategy to explain guidelines and instructions to learners as well as explain misconceptions. As far as the role of the teacher is concerned, the exploration phase could be linked with the inquiry strategies of as structured level, and this level accommodates all learners of different learning abilities as the guided and open inquiry would be more challenging to learners who are below average.

2.3.3.3 Phase 3: Explain

Duran and Duran (2004) assert that "the explanation phase enables learners to describe their understanding and pose questions about the concepts they explored" (p. 52). The concepts, practices and abilities with which learners were originally engaged and subsequently explored, are now made clear and comprehensible (Bybee, 2014). The teacher asks learners and encourages them to compare their prior knowledge with the observations of the previous phase and explain the relationship between those (Bybee, 2014; Çepni & Şahin 2012). Furthermore, in the explanation phase, the role of teachers is to facilitate learners by asking them to explain and discuss their learning experiences in the exploration phase. Another role of the teacher is to clarify learners' misconceptions that emerged from the engagement and exploration phases thereby providing definitions of concepts based on the syllabus'

competencies as well as providing notes. At this phase, teachers should be able to use both their GPK and PCK and should apply their knowledge of learners' understanding whereby they need to bear in mind learners' prior knowledge and understanding on the topic under discussion. Teachers should use their categories of knowledge to create a conducive environment where learners will be able to explain their understanding on the topic without fear. In addition, teachers may also provide learners with video clips on the topic and other printed materials as resources to reinforce the understanding of concepts. The explanation phase is therefore more linked to the structured and guided inquiry level since learners are provided with guidelines to which they should base their explanations and discussions.

2.3.3.4 Phase 4: Elaborate

Duran and Duran (2004) emphasise that "the goal of this phase is to help develop deeper and broader understandings of the concepts" (p. 53). The activities in this phase should aim to challenge students with new situations and inspire interactions among students (Bybee, 2014). In the same vein, Cardiac, Dikmenli and Saritas (2016) and Çepni and Şahin (2012) maintain that activities in the elaborate phase should encourage learners to expand and solidify their new understanding of those concepts they have acquired and apply this new understanding to a real world situation, while strengthening new skills. The teachers' role in the elaborate phase is to challenge learners by providing them with new problems and encourage them to interact with one another and to use different resources to support and extend their understanding. Teachers are therefore responsible for encouraging learners to apply new understanding to real life situations so as to deepen their understanding. In order to fulfil the roles of teachers at the elaborate phase, these teachers should have sound PK, GPK and PCK to be able to confront learners with activities that provoke them

to expand their thinking skills. Furthermore, the elaborate phase could be linked to the open inquiry level as learners are allowed to apply the acquired skills and knowledge and to put them into practice.

2.3.3.5 Phase 5: Evaluate

Bybee (2014) suggests that the evaluation phase encourages students to assess their understanding and abilities, and provides opportunities for teachers to evaluate student progress towards achieving the educational objectives. During this stage, learners should also receive feedback on the adequacy of their explanations and abilities. According to Duran and Duran (2004), learners may also have the opportunity to conduct self-assessments and peer-assessments. Such evaluation may also include summative experience such as a quiz, exam or a writing assignment. The role of the teacher in an evaluation phase is to assess and evaluate learners' understanding of new concepts. It is also at this phase that teachers are expected to provide feedback on learners' mastery level while assessing them. The evaluation phase is linked to all levels of inquiry strategies since assessment is a continuous process, so learners should be assessed continuously at each phase. At this phase teachers are required to make use of their GPK, PK and PCK to prepare and design activities for assessing and evaluating learners as per the syllabus' competencies.

2.3.3 Knowledge required to utilising an inquiry method

Good-quality teachers, with up-to-date knowledge and skills, are the foundation of any system of formal Science education (Alake-Tuenter et al., 2012). Furthermore, Lederman (2007) posits that "a teacher must possess an adequate knowledge of what

he/she is attempting to communicate to learners" (p. 839). Building on the work of Appleton (2003) and Osborne (2003), Gillies and Nichols (2014) point out that "knowledge of science content as well as content-specific strategies in identifying students' misconceptions, promoting inquiry and encouraging group collaboration and problem solving are critically important if teachers are to be effective in implementing inquiry science in their classrooms" (p. 2). The inquiry methods requires complexities and challenges of knowledge in teaching particular concepts, and how to address such teaching and learning challenges that may arise during instruction. Keys and Bryan (2001) carried out a study to investigate the co-constructing inquiry-based science with teachers and argued that "teachers who use an inquiry approach must have a rich and deeply developed understanding of science content, student learning, the nature of science and ways to engage learners in investigative practices" (p. 637). As articulated by Alake-Tuenter et al. (2012) and Lederman (2007) that teachers should have an up-to date and adequate knowledge and skills of what they are teaching, this knowledge may include knowledge of interpreting the syllabus basic competencies into teaching and learning activities as well as implementing them during instruction.

Empirical research investigating ways in which teachers' knowledge is utilised in decision-making by Guerriero (2014) suggested that in order to make informed pedagogical decisions, teachers must be able to analyse and evaluate specific learning experiences in combination with contextual and situational factors. In addition to that, they must also be able to connect all this information to their specialist knowledge of the teaching-learning process in order to guide subsequent teaching actions. Hudson (2013) furthermore mentions that, through their plans of

teaching, effective teachers aim to meet the requirements of their education system and ensure that teaching becomes purposeful and transparent. During the inquiry method, teachers are required to use their pedagogical knowledge to decide on the teaching strategy to employ during instructions based on the subject content, learners' abilities and availability of resources.

Mkimbili, Tiplic and Ødegaard (2017) in their study on exploring the practice of Inquiry-Based Science Teaching (IBST) in schools with contextual challenges in Tanzania found that in-service and pre-service teacher training should focus on preparing teachers to conduct practical demonstrations, supported by investigative questions rather than teacher-centred demonstrations. Furthermore, Nakanyala (2015) study to investigate the factors affecting the effective teaching of Physical Science in 14 secondary schools in the Oshana Educational Region suggests that Physical Science teachers should compensate for unavailable laboratory materials by improvising with alternative materials from the environment such as empty containers and tins and recyclable materials for practical work in their teaching. Such an approach may support the practice of inquiry teaching in schools with limited resources.

The nature of Physical Science as a subject is comprised of theories and laws that need approval by conducting laboratory experiments and investigations. In most cases, teachers find it difficult to carry out some experiments or investigations due to the fact that they do not have ideas on how to conduct them and sometimes some apparatus that are supposed to be used are not available. As a result, teachers are left with the option of teaching theory without demonstrations or experiments. To

address the problem of lack of apparatus for demonstrations and experiments, Nakanyala (2015) advised that teachers should make use of recycled materials and other alternatives available locally for their experiments and demonstrations. Furthermore, there is a need to provide Physical Science teachers in Namibia with training on how to conduct varieties of experiments and demonstrations on different topics of the subject, to ensure that they are well equipped in carrying out all practical investigations prescribed in the syllabus.

Professional development training should provide activities where teachers explore their knowledge of inquiry, as well as getting involved in the inquiry process by generating scientific questions and designing/conducting investigations in the laboratory and field studies. These investigations, combined with numerous classroom activities that model pedagogical techniques present opportunities for teachers to build their content and pedagogical knowledge and skills for inquiry teaching (Bell et al., 2001; Mokiwa, 2014). Liswaniso (2019) carried out a study to investigate the teaching of Biology and Physical Science practical works in ten Senior Secondary Schools in the Zambezi Region, Namibia. Liswaniso reports that Physical Science teachers had indicated the need for training workshops regarding the way to design, set up and carry out certain practical works. However, Mokiwa (2014) argues that the current tendency of education authorities to run a one or two-day workshop is insufficient to equip teachers with the necessary skills required to implement the inquiry method. Rundgren (2017) as cited in Vanosdall (2007) points out that "one of the most obvious reasons Science teachers do not retain and transfer the knowledge and skills gained in professional development sessions is the lack of continuing support for them to incorporate changes in their classroom practices" (p.

3). Manditereza (2016) conducted a study to investigate current pedagogic practices engaged by teachers from different cultural backgrounds when teaching English as a medium of instruction and how their practices affect learners in acquiring knowledge of the English language in South Africa. Supporting this view, Manditereza (2016) noted that most teachers agreed that there was a need to promote the continuing professional development of teachers because of constantly changing policies in education and the fact that educationists seem to be running out of ideas with the current curriculum.

The importance of Teachers' Professional Development (TPD) is supported by Rundgren (2017) who draws on important features that characterise successful TPD programmes, as described by Horsley, Stiles, Mundry, Love and Hewson (2010) as follows:

- Effective professional development is designed to address learners learning goals and needs;
- Effective professional development experiences are driven by a well-defined image of effective classroom learning and teaching. This image includes, for example, a commitment to all science learners, an emphasis on inquiry-based learning, investigations, problem solving and applications of knowledge, an approach that emphasises in-depth understanding of core concepts and challenges for learners to construct new understanding and clear means to measure meaningful achievement;
- Effective professional development experiences provide opportunities for teachers to build their content and pedagogical content, knowledge and skills, as well as examine and reflect on practice critically;

- Effective professional development experiences are research-based and engage teachers as adult learners in the learning approaches they will use with their learners;
- Effective professional development provides opportunities for teachers to work with colleagues and other experts in teaching communities to continually enhance their practice.
- Effective professional development experiences support teachers to deepen their professional expertise throughout their careers and serve in leadership roles.
- Effective professional development experiences provide links to other parts of the education system (p. 61-62).

Professional development training to be provided to Science teachers, in particular, Physical Science should aim to address the current issues faced by teachers such as conducting certain experiments, interpreting specific competencies from the syllabus as well as planning and preparing an inquiry lesson. Such trainings should include activities in which teachers are actively involved in conducting experiments and getting trained on how to prepare specific re-agents for instance, so that they will be able guide their learners when carrying out practical investigations at schools.

2.3.4 Challenges faced by teachers when employing an inquiry method

Through various research and scholarly pieces, numerous challenges facing teachers in implementing inquiry teaching were identified such as lack of exposure to inquiry-based methods during teacher training, inadequate content knowledge, inadequate knowledge of the Nature of Science (NOS) and a lack of pedagogical skills in

inquiry methods (Donnelly & Linn, 2014; Gillies & Nichols, 2014; Lederman, 2007; Ssempala 2017; Wade, Benson & Switzer, 2012). However, Ahokoski, Korventausta, Veermans and Jaakkola draw on the work of Lewthwaite (2006) who suggests that "the development of science teaching in general is influenced by two factors namely: teachers' personal attributes/factors (internal factors) such as interest, motivation, teaching efficacy and professional science knowledge, and environmental factors (external factors) such as limited time and resources, insufficient external support from the school community and the interaction of these factors" (p. 306).

The literature above suggests that challenges facing science teachers in implementing the inquiry method differ from one teacher to another. In some cases, teachers may not use inquiry methods because they have no idea of conducting a lesson by inquiry. Sometimes teachers do not have confidence to conduct inquiry instructions due to insufficient subject knowledge and lack of skills on how to use some apparatus, carrying out experiments or demonstrations. The main challenge science teachers may be faced with in implementing the inquiry method is that most classrooms seem to be overcrowded and teachers usually rush to finish the syllabus, rather than teaching for understanding. Furthermore, teachers seem to be mostly overloaded with two or more different content subjects and grades to teach and might not have enough time to plan and prepare for every prescribed practical investigation as per the syllabus.

In the same vein, Peleg et al. (2013) argue that one of the main factors hindering teachers from implementing inquiry teaching is perceived lack of confidence in leading inquiry activities and teachers' uncomfortability to involve learners in such

activities. Mokiwa and Nkopodi (2014) in their South African study on exploring teachers' instructional practices and conceptions of teaching Physical Science through inquiry, indicated that Physical Science teachers used traditional classroom activities more frequently than inquiry-based activities; and whenever they made use of inquiry, they followed a specific order of activities that led to a more structured or direct type of inquiry. Other major aspects hindering the use of inquiry-based laboratory sessions were found to be fear of failing to address the content of the course utilising this pedagogy, challenges in designing effective inquiry-based laboratories (Comley, 2009; Duran & Duran, 2004) and demands for a more traditional approach from students and parents (Comley, 2009). Adopting a similar position, Liswaniso (2019) argues that some Science teachers in Namibia had difficulties preparing and designing practical works that could help learners acquire certain practical skills. As a result, not all prescribed practical works in the syllabi were covered, and this hindered learners in acquiring the practical skills as per the subject objectives. However, the inability by some Science teachers to prepare and conduct practical work frequently during instructions negatively affects learners' acquisition of investigation skills as per competencies in the syllabus. As a result, learners taught by teachers who lack practical work skills would hardly develop practical and investigation skills, which are the foundations of acquisition scientific skills.

Wade, Benson and Switzer (2012) in a study on investigating the experience of secondary Science teachers who advanced their understanding of inquiry-based learning and instruction in India claim that the difficulties teachers faced while developing and implementing inquiry-based instruction were their own

understanding of the approach, adequate time and resources. The most challenge that teachers face with designing and carrying out the inquiry method relate to teachers' personal factors such as lack of skills and understanding on how to conduct inquiry lesson, lack of resources at school and inadequate time to attend to individual groups of learners while conducting investigations (Gillies & Nichols, 2014).

According to various scholars some teachers find it difficult to employ the inquiry method during instruction because they lack the skills and expertise to design teaching and learning activities which are inquiry based (Liswaniso, 2019; Wade, Benson & Switzer, 2012; Mokiwa & Nkopodi, 2014). It seems that most teachers are not trained on how to use the inquiry method during teachers' training, and neither have they received in-service training on how to conduct any practical work based on the syllabus.

Previous studies have identified common external factors that impede on the utilisation of inquiry methods such as inadequate resources, overcrowded classrooms, time constraints and the large amount of content to be covered (Kurumeh, Jimin & Mohammed, 2012; Liswaniso, 2019; Mumba, Mejia, Chabalengula & Mbewe, 2010). According to Mkimbili, Tiplic and Ødegaard (2017), most Science teachers could frequently not conduct practical work due to lack of functional laboratory equipment, textbooks and sources of energy and water, which made it difficult to prepare and store specimens for practical investigations.

Most competencies in Physical Science syllabus require learners to be able to carry out practical activities where they should be able to apply scientific skills such as handling of apparatus, collecting data, recording and interpreting results as well as

drawing conclusion. Furthermore, most of the investigation skills that are used in practical work are the same skills learners need to develop during the inquiry method, hence practical work is part and parcel of the inquiry method.

The researcher being a Physical Science teacher for years observed that lack of laboratory facilities is a big challenge most especially at schools that offer science subjects at higher level, where learners are supposed to be exposed to frequent laboratory investigations. However learners are only allowed to carry out few investigations in the classroom for practical examination preparation. In most cases, priority is given to Science subject higher level learners to carry out experiments while learners from other grades doing other subjects might not have any opportunity to carry out or observe the teacher demonstrating laboratory experiments; reason being that there are no enough laboratories at schools.

Supporting the views regarding external factors that affect teachers' utilisation of the inquiry methods, Dhurumraj (2013) maintain that "practical and theoretical lessons in large classes, together with limited resources become very difficult and more time is spent on disciplining learners rather than teaching and learning" (p. 61). According to Liswaniso (2019), Science teachers experience problems with laboratory space which is limited for large classes, learners' inability to interpret experimental results, learners' non-exposure to practical works from lower grades, lack of interest in practical work and indiscipline, as well as lack of communication and observation skills when conducting practical work.

As far as the roles of the learners are concerned in an inquiry lesson, teachers find it difficult to allow learners to carry out investigations and experiments due to the fact that laboratories are smaller and cannot accommodate the whole class carrying out investigations in different groups at the same time. Furthermore, teachers are faced with a huge responsibility of controlling and disciplining a large number of learners in a laboratory at a time, which is a difficult task. As a result, teachers are left with no option but rather to do the experiment themselves while learners observe.

Nakanyala (2015) found that major factors inhibiting Physical Science teachers in Namibia from employing teaching methods perceived as effective in their teaching included learners' attitudes towards learning Physical Science, poor teaching background of Physical Science and poor English proficiency. Furthermore, most learners were not willing to participate in class activities or complete tasks assigned to them. Based on an investigation into the effectiveness of inquiry teaching method on senior secondary students' achievement in algebra in four schools in Onitsha Education Zone of Anambra State, Nigeria; Kurumeh, Jimin and Mohammed (2012) noted that, when learners are presented with inquiry activities, they may become frustrated if they fail to solve the problems themselves. However, Ural (2016) maintains that thinking and searching processes are difficult for the learners because the development of these skills is a matter of process, hence, developing them in a short period of time is impossible; consequently, they cannot conduct research processes properly. Research evidence reveals that a large part of the Physical Science syllabi contents affects practical work teaching and time allocated for Physical Science lessons might not be sufficient (Liswaniso, 2019; Nakanyala,

2015); hence, the inquiry teaching method could result in less coverage of the scheme of work, if not properly handled (Kurumeh, Jimin & Mohammed, 2012).

In support of the above view, Nakanyala (2015); Kurumeh, Jimin and Mohammed (2012) and Ural (2016) highlighted that learners' poor background of Physical Science and English proficiency can affect their attitudes toward the subject, and their involvement and participation during instructions might be negatively affected. As a result, teachers are forced to divert from the inquiry method to the traditional teaching method, the teacher-centred method where teachers carry out all the steps. The teacher asks questions, explains the procedure, carry out the investigation, involve learners in taking readings and record them; and then analyse and interpret data and give conclusion.

Contrary to previously published studies, Wilcox, Kruse and Clough (2015) demonstrate that effective teaching of Science through inquiry requires a structured environment where learners understand what they are trying to achieve and the teacher sets clear expectations for on-task behaviour, as well as monitors learners broadly and provides scaffolding assistance where needed. Wilcox, Kruse and Clough (2015) further added that "when teachers effectively create this environment, students are mentally and physically engaged and thus classroom management issues are often less dominant than in more typical science classrooms" (p. 63). However, contrary to the above assertion, effective teaching of Science through inquiry would only be possible provided that teachers have good PK, GPK and PCK and can create an environment where learners understand their roles while striving towards

achieving their goals. However, the challenge is that most teachers lack inquiry skills and are unable to design and conduct inquiry teaching and learning activities.

As a response to the challenges facing Physical Science teachers regarding the use of inquiry methods, specifically on lack of skills on how to design and conduct inquiry teaching and learning activities; teachers should therefore be provided with continual professional development training on inquiry methods. Supporting the view of Manditereza (2016), in-service training provided to teachers should be continuous and aim at empowering teachers by equipping them with the recent skills and knowledge required for implementing the changing curriculum, including skills on inquiry method. In-service training should not only be provided when the curriculum changes, but should be continuous to ensure that all teachers have the required skills and expertise and that they are at par with the requirements of the subject content and syllabus.

2.4 Summary

In this chapter the researcher presented the theoretical framework, pedagogical knowledge on which this study was based. The researcher also provided a review of literature regarding the ways in which different authors define the inquiry teaching method and knowledge required to employ the inquiry teaching method, as well as the challenges faced in implementing the strategy. Some of the positive outcomes of the inquiry teaching method include a deeper understanding, higher degree of reflection, the achievement of higher order learning and more motivation. Numerous studies have identified the challenges most teachers face in implementing inquiry teaching. Some of these are lack of inquiry teaching skills, limited resources at schools, too much content or too large syllabus for Physical Science, as well as

overcrowded classrooms. The next chapter therefore outlines and describes the research methodology of this study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

In this chapter the researcher outlines the methodology used to conduct the study. The chapter is comprised of a detailed description of research design, population, sampling and sampling procedure, instrument, data collection procedure, data analysis, pilot study and ethical considerations.

3.2 Research Design

Creswell (2013) defines research design as the set of specific procedures involved in the research process such as: data collection, data analysis and report writing. The study employed a qualitative, exploratory research design to explore the pedagogical knowledge and classroom practices regarding the inquiry method of Physical Science teachers. The study is qualitative as it involved an in-depth investigation of pedagogical knowledge required and utilised by Physical Science teachers when they employ the inquiry method in their instructions.

3.3 Population

A population is “a group of individuals who have the same characteristics” (Creswell, 2012, p. 142). The targeted population for this study was 104 Physical Science teachers from 34 secondary schools in the Khomas education region that offer Physical Science at Ordinary level.

3.4 Sample and Sampling Procedures

A sample is a subgroup of the target population that the researcher plans to study so as to generalise the population (Creswell, 2012, p. 142). Extreme case sampling was used to select one secondary school that was at the top of the ranking and two secondary schools that were at the bottom of the rank in the Khomas education region for the NSSCO Physical Science results of the year 2018. An extreme case sampling is "a form of purposeful sampling in which the researcher studies an outlier case or one that displays extreme characteristics" (Creswell, 2012, p. 208). For instance, the researcher chose two schools which performed best than others and two least performing schools in Physical Science Ordinary level in 2018 external examination results in the Khomas region. The extreme features for the participated schools in this study are schools being the best performed and being the least performed in that specific subject in that particular region. Marten (2015) proposed that the study of extreme cases might yield information that would be relevant to improving more typical cases. Among the top performed secondary school, only one (second) top performed school (school A) participated in the study, with the first top performing school declining to take part in the study. The other two schools (school B and C) were schools at the bottom of the ranking of the NSSCO Physical Science results for the year 2018. This gives the total number of schools that participated in the study to be three (3).

Purposive sampling was used to select two Physical Science teachers at each school who had experience in teaching Physical Science for more than three years. Purposive sampling was used in order to access 'knowledgeable people' who have

in-depth knowledge about a particular issue by virtue of their professional role, power and expertise or experience (Cohen, Manion & Morrison, 2011, p. 157). In this study, the knowledgeable cohort includes Physical Science teachers who have taught the subject for more than three years. Among the three participated schools, only one teacher from the second bottom performing school agreed to take part in the study while the other two teachers were from two other schools. Hence, the total sample of the study consisted of five (5) participants out of 10 teachers from all three (3) schools. One (1) teacher who participated in the study was from school A, two (2) teachers from school B and two (2) other teachers from school C.

3.5 Research Instruments

Wilkinson and Birmingham (2003) defines research instruments as simply devices for obtaining information relevant to the research project. Research instruments used in this study include: a questionnaire, an observation checklist, and structured interviews. These instruments are outlined in more detail in the next sub-sections.

3.5.1 Questionnaires

According to Wilkinson and Birmingham (2003), questionnaires can be designed and used to collect vast quantities of data from a variety of respondents. Wilkinson and Birmingham (2003) further added "that an effective questionnaire is one that enables the transmission of useful and accurate information or data from the respondent to the researcher" (p. 8). In this study, questionnaires were used to collect data regarding teachers' biographical data, academic and professional qualifications and instructional methods used by Physical Science teachers in their lessons. The questionnaire consisted of five sections comprised of: participants' background

information; information about inquiry teaching method; instructional strategies used; steps in inquiry teaching method and pedagogical strategies. The questionnaires consisted of open ended questions. The researcher opted for open ended questions for the following reasons: “the open-ended question permit a free response rather than restricting the participant to a choice from stated alternatives” (Ary, Jacob, Sorensen & Walker, 2014, p. 418). That is, a participant with more opinion on the issue will not feel restricted, thus will provide as much detailed responses as possible. Questionnaires were administered to all three participants (Physical Science teachers) before the first lesson observation and collected the next day after the second observation. The questionnaire is given on Appendix H.

3.5.2 Interviews Guide/Schedule

An interview is one of the most widely used basic methods for obtaining qualitative data (Creswell, 2014). An interview, according to Jacob and Walker (2014) has an advantage of supplying a large volume of in-depth data quickly from people about opinions, beliefs and feelings about the situation at hand. Similarly, Wilkinson and Birmingham (2003) stated that “while other instruments focus on the surface elements of what is happening, interviews give the researcher more of an insight into the meaning and significance of what is happening” (p. 46).

In this study a face to face structured interview was conducted with each teacher for 45 minutes for an entire period after the second lesson observation. The structured interview guide (see Appendix I) consisted of six (6) open-ended questions. The purpose of an interview was to get insight-depth information about the use of inquiry methods; teachers’ knowledge of inquiry teaching method; sources of their

knowledge on the inquiry teaching method. The study was further aimed at finding out whether teachers have been trained for inquiry methods during or after their teacher training and whether they are still in need of the training. The researcher also used interviews to find out about teaching strategies Physical Science teachers are required to use during the inquiry method; challenges they are facing in implementing the method as well as the support they need from stakeholders in education concerning the inquiry method.

3.5.1 Observation checklists

Observation is defined as "a process of gathering open-ended, first-hand information by observing people and place at a research site" (Creswell, 2012, p. 213). According to Cohen, Manion and Morrison (2011), observational data enables the researcher to observe things that participants might not freely talk about in an interview situation, to move beyond perception-based data and to access personal knowledge. Wilkinson and Birmingham (2003) suggested the use of an observation checklist instrument when the ways in which people behave and interact with one another in a social setting are important to the research or when interested in researching social settings and what happens in them.

In this study ten (10) lessons were observed (two lessons per participant) during school days from 7h00 to 13h20. The focus of the observation was to understand the teaching methods used, teaching and learning activities used in the lesson, and classroom management (see Appendix G). In other words, the observation focused on how often teachers engaged learners in class, lesson presentation logic, use of teaching materials and assessment of the learners.

3.6 Pilot Study

Cohen et al. (2007) define a pilot study as a small study conducted in advance of a planned project, specifically to test aspects of the research design and to allow necessary adjustments before final commitment to the design. Ary et al., (2014) assert that a pilot study provides the opportunities to assess the appropriateness of data collection methods and other procedures and to make changes if necessary. Furthermore, Oppenheim (1992); Morrison (1993); and Wilson and Mclean (1994), as cited in Cohen, Manion and Morris (2007) proposed the following as the functions of a pilot study:

- To check the clarity of the questionnaire items, instructions and layout;
- To gain feedback on the validity of the research instrument's items;
- To eliminate ambiguity or difficulties in wording;
- To identify omission, redundancy and irrelevant questions; and
- To check readability levels for the target audience (p. 47).

A pilot study was conducted one month prior to the main study at two secondary schools in the Otjozondjupa education region. All three instruments namely: classroom observation checklists, questionnaires and interviews were pilot tested at both selected schools, where two Physical Science teachers from each school participated. The following changes were made after piloting the instruments: on the questionnaire, Section A, question 5 was initially phrased like this: "*How long have you been teaching Physical Science in Grade 12*? The question was changed to "*How long have you been teaching Physical Science*?" Question number 5 was changed because the study focus was on secondary school teachers' pedagogical knowledge regarding inquiry teaching method and it was not focusing on Grade 12 Physical

Science teachers only. This means that, not all participants in the pilot study were currently teaching Grade 12 Physical Science, others were teaching grade 8, 9 10 and 11.

Furthermore, on the Classroom Observation Checklist Section B **Pedagogical Strategies,** two items namely: *Learners are allowed to use different methods to solve problems* and *Learners are asked to give more than one solution to the problem* were deleted under the **Questioning Techniques** section, because these two items already appeared under the section **Implementation of Lesson**.

3.7 Data Collecting Procedures

Firstly, permission from the Ministry of Education, Arts and Culture was sought and obtained. After obtaining permission from the Executive Director and Regional Director of Education in Khomas education region, the researcher approached school principals and teachers for approval of the researcher to conduct the study at their respective schools. Thereafter, the researcher obtained approval from the school principals and later made appointments with participating teachers as to when they could be observed and interviewed based on the participants' availability/timetable. The researcher explained the aim of the study to participants as well as the role which participants were expected to play in the study. Subsequently, each participant was given a consent form (see Appendix 7) to read before signing to indicate that they agreed to take part in the study. The data collection period involved three stages which are outlined below:

3.7.1 Stage 1: Questionnaires

A questionnaire was administered to each participant and collected the next day. The questionnaires were administered one day before collection day in order to give participants enough time to answer the questionnaire items.

3.7.2 Stage 2: Interview

Each participant was interviewed for 10-15 minute. Some participants were interviewed during their free periods; while others were interviewed immediately after school. Permission was requested from each participant for an interview to be audio recorded and they all agreed. The data collected during the interview were audio recorded using a Galaxy A2 Core sound recorder. Drawing from Creswell (2012), the researcher took brief notes during the interviews to help as a back-up in the event of tape recorder malfunction. Therefore, apart from collecting data during the interview by audio recording, the researcher was also too short notes during the interview sessions. The study was undertaken during school hours, during the first trimester of the school for the duration of two weeks.

3.7.3 Stage 3: Observation

Each participant was observed for 45 minutes as per the duration of the period in two different lessons during school hours. The researcher used an observation checklist to mark off the displayed behaviours by both teachers and learners during the lesson as per item in the checklist. The researcher was a complete observer or non-participant observer during the lesson observation; thus avoiding interacting and communicating with the teacher and learners (Creswell, 2012). The researcher was a non-participant

observer during the lesson observation to ensure that the presence of the researcher would not have any influence on the teaching and learning activities.

3.8 Data Analysis

According to Cohen et al. (2011) ‘‘qualitative data analysis involves organising, accounting for and explaining the data; in short, making sense of data in terms of participants’ definition of the situation, noting patterns, themes, categories and regularities’’ (p. 537).

The initial stage in the data analysis process was to verbatim transcribed data collected from the interviews and observations. After the data was transcribed, the next stage was coding of data from all the instruments (i.e. Interviews and observation checklists). Kerlinger (1970) defined coding “as the translation of question responses and respondent information to specific categories for the purpose of analysis” (2007, p. 480). Transcribed data were coded by labelling them with phrases or words that made it easy to categorise them into themes. The researcher read through the coded data several times in order to further categorise data into themes based on the research questions. Furthermore, data were presented in tables, hence, qualitative thematic analysis methods were employed to analyse and interpret data for this study.

3.9 Ethical Considerations

The researcher obtained an ethical clearance certificate from the UNAM Research Ethics Committee before applying for permission to conduct research from the Executive Director of the Ministry of Education, Arts and Culture, the Director of

Education, school principals and teachers in the Khomas education region. After permission was granted, the researcher developed an introductory letter for participants that assured them of their rights to withdraw should they want to. Participants were given a consent form to sign as an indication that they agree to take part in the study. The identity of all participants as well as that of their schools were kept anonymous. The data collected were kept confidential by storing interview responses in a locked briefcase, to which only the researcher had access. Audio-recorded data was stored for three years in a personal computer protected with a password. Data in hard copy was destroyed after three year and soft copy data was deleted from the drive. Participants and their schools were given codes such as P1, P2 and P3 to identify them and keep them anonymous throughout the study.

3.10 Summary

In this chapter, the researcher outlined the research methodology that was used to conduct the study. The research design used for the study was discussed which comprised of the population, sample size and sampling procedure, instruments used to collect data, pilot study, data collection and data analysis. Ethical considerations were also discussed under this chapter. The next chapter presents the researcher's presentation, results and discussion.

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter presents the data and discusses the results of the study. The aim of this study was to investigate the PK and practice of the inquiry method by Physical Science teachers at secondary school level in the Khomas educational region. Three main themes as determined by the research questions were addressed. These are:

Theme 1: Physical Science teachers' perceptions about pedagogical knowledge of inquiry method.

Theme 2: How Physical Science teachers practice their pedagogical knowledge through the inquiry method.

Theme 3: Challenges faced by Physical Science teachers when employing/practicing the inquiry method.

The next section presents the result from the questionnaires, interview and the observation checklists as per item according to the research questions. The biographic information of participants from the questionnaires will first be presented.

4.2 Biographic Information of the Participants

All participants were coded so as to use those codes to refer to a certain school or teacher. Schools were coded with letters A, B and C, while teachers or participants were coded using: T1, T2, T3, T4 and T5. Table 2 presents participants codes, their respective schools and the demographic information.

Table 2: Teachers and schools codes

Schools codes	**Teachers' codes**		**Age**	Qualifications	Major Subjects	Years of teaching experience	Total
	Female	**Male**					
A	0	T1	31-40	Bachelor of Education (B. Ed.)	Biology and Chemistry	1- 5	1
B	T2	T3	31-40 41 - 50	Bachelor of Education (B.Ed.) Bachelor of Education (B.Ed.)	Home Economics Physical Science and Mathematics	10-15 15 and more	1 1
C	0	T4 T5	31-40 31-40	Basic Education Teacher Diploma Bachelor of Education (B.Ed.)	Biology and Physical Science Physical Science and Mathematics	5 – 10 10 - 15	1 1
Total	**1**	**4**	**5**				**5**

Based on the 2018 Physical Science results of NSSCO National examinations in the Khomas education region, the school coded **A** was the first from the bottom of the rank, while the one coded **B** was the second from the top and school coded **C** was the second from the bottom of the rank. Top ranking is the school that performed well in the Physical Science NSSCO Ordinary level among all other schools in the region, while the bottom ranked school is the one that performed least in the whole region in the Physical Science NSSCO Ordinary level examinations of 2018.

4.3 Pedagogical Knowledge and the practice of Inquiry Method

The first section focuses on presenting results for the pedagogical knowledge (PK). Three instruments were used to collect data about the PK of Physical Science

teachers. The research results are presented in this order: Data from the questionnaire (open-ended questions) and interviews then the lesson observations.

4.3.1 Findings from the questionnaires and interviews based on teachers' perceptions about pedagogical knowledge of inquiry method

Questionnaires and interviews were used with the aim to get more insight from teachers on how they used the inquiry method to transfer subject content to the learners. Results obtained were presented based on the items in the questionnaires and interview guide as per research question one.

On whether teachers use inquiry teaching in their daily teaching and to describe how they use it, teachers' responses are presented as follows:

Teacher T 1 replied:

Yes, *in Physical Science at the start it is one of the problematic subject so to say, so one has to design the lesson such a way that you first engage learners into the topic particularly the first lesson, you engage them to get their attention and put their attention to the subject content and subsequent subthemes. After engaging them, then with time then you let them explore and maybe give them an activity to do which can be in the form of a project where they explore to find out information, It is also imperative to then let them report their findings and draw conclusions and when there is a need to explain, they explain their findings in the form of tables, diagrams or graphs.*

Teacher T2 responded that:

Yes, I use inquiry teaching when I want to establish the knowledge that learners know beforehand. It is the starting point.

Teacher T3 responded that:

Yes: I normally use it when I am giving an exercise or activities that learners must go and work out on their own.

Teacher T4 responded that:

Yes, I use it. In most case it is in the introduction, where you want to test their prior knowledge or know how far they are already acquainted with the knowledge of the topic or new chapter that you are introducing that specific day. So you give them the competencies and then they have to explain or discuss what is in the competencies, just to see how far they are and where you start with a new topic. If it is a continuation lesson then I use it more to see if they can connect a previous lesson with what is introduced now because that is where they show you that they can relate to what was taught, to what is been taught now. It is very effective, because if you do not do that, it is more like you are singing to yourself and do not know where they are; meaning that they will be sitting saying, 'can she not finish, because we know this already'. But at least if you do that it also gives you the level of understanding of your learners in class. It is more for introductory but can also be used in the middle of the lesson if you have new competencies because some of the competencies are very short can be tackled at once. If you have a new topic that you are talking about you then can inquire them and relate to real life situation.

Teacher T5 responses:

Yes! Basically, what happens is that, it is like the act of going to find out deeply in the learners what they know about a specific topic of that subject. Let me say for example, may be I am busy with a subject matter, I have to make them come up with what they know about that specific topic of that subject based on the experience on the previous grade where they came from. That is the part of inquiry where I go in-depth trying to find out before I bring in my part. That is now in the form of questions where I ask them question which I can now link with the current topic that we are busy with in the classroom.

Results from this study revealed that all teachers used inquiry method, although they use it in different ways. Teacher T2, T4 and T5 indicated that they used the inquiry method at the introductory level of the lesson in order to assess learners' prior knowledge about the topic to be covered during the lesson. On the other hand, teacher T1 stated that he used the inquiry method to engage learners and to get their full attention throughout the lesson. Another teacher (Teacher 4) added that the inquiry method was more appropriate to use when assessing the learners' prior knowledge on a new topic to be taught in order to identify misconceptions and find out the level they are in relation to the subject content. Teacher T3 indicated that he used the inquiry method by giving exercises or activities that learners must go and work out on their own. Furthermore, teacher T5 added that he used the inquiry method by asking learners questions related to the current lesson content in order to link what learners know already with the current lesson content. Findings emerged from research question one revealed that all teachers who participated in this study use the inquiry method; however, the effectiveness of the use of the inquiry method

may depend on other factors including knowledge that teachers require in implementing the inquiry method.

All teachers responded that they use the inquiry method to interact with learners and to get them involved in the topic under discussion and in the learning process. With regard to why they use some teaching method more than others, a range of various answers were provided as follows: it's because it took less time and motivated learners to be actively involved and to participate in the lesson, science is a question based disciplines aiming to find the truth to improve life, to observe learners' practical skills and enable teachers to correct them on time, and where learners can be easily guided and controlled, where much of the subject content can be covered per lesson.

4. 3. 2. Findings from observation checklists based on teachers' perceptions about pedagogical knowledge of inquiry method

Classroom observations were conducted with the aim of supporting or contradicting the claim that Physical Science teachers used inquiry method as they have indicated in the questionnaires and substantiate what was provided in the interview. The researcher observed teachers teaching different topics from grade 8, 10, 11, and 12 in Physical Science and Chemistry. Results that emerged from observation checklists were presented based on the items in the observation checklists.

Steps in inquiry method

Under this item the researcher aimed to determine how many times teachers followed inquiry steps during their lesson presentation. The number of times of following steps of inquiry method were determined by using the observation checklist with statements on teachers and learners' behaviours during inquiry method. The number of times was then recorded as observed during the lesson. The number of times of Physical Science teachers' use the steps of inquiry method is shown in Table 8 below:

Table 3: Frequency of the use of steps of the inquiry method

Engage	**No. of times**
1. 1. Learners identify problem	8
1. 2. Activity provided an opportunity for active learning	7
1. 3. Learners are asked questions to assess their prior experience about the topic	9
1. 4. Connections between previous and present learning experiences are made	8
Explore 2. 1. Learners are encouraged to use prior experiences to generate new ideas	6
2. 2. Learners explore possibilities	4
2. 3. Learners are allowed to design and conduct investigation through activities	1
Explain 4. 1. Learners are involved in analysis of their exploration	3
4. 2. Learners explain their understating of the topic	5
Elaborate 4. 3. Learners extend their understanding	7
4. 4. Learners make connections to other related concepts	7
4. 5. Learners apply their understanding to the world around them	5
Evaluate 5. 1. Teacher and learners evaluate the activity/project as a whole	8

Results from Table 3 indicated that the engagement step was the one of the phase with more counts ranging from seven (7) counts and more per behaviour. The evaluate step had eight (8) counts for its only one behaviour, followed by elaborate step which had seven (7) counts for two different set of behaviour and five (5) for one behaviour. The explore step had six (6), four (4) and one (1) counts for different behaviours. The explain step has the least occurrence of three (3) and five (5) counts per behaviour respectively.

The behaviour presented as: *Learners were asked questions to assess their prior experience about the topic* in the engagement phase, had 9 counts, which was the highest compared to all other behaviours in all phases. These findings coincide with the results from the questionnaires which indicated that teachers used to engage learners always in their lessons. Therefore, from these findings one can conclude that some teachers really use the inquiry method during their lessons. Whereas, the behaviour '*Learners are allowed to design and conduct investigation through activities*' from the explore step have one count indicating that teachers do not allow learners to handle materials and conduct investigations more on their own.

Both findings from the questionnaires and observation checklists are supported by Duran and Duran (2004) who emphasised that in order for learners to learn and gain an understanding of science concepts, they must be actively engaged in their own learning. Teachers must guide their learners in directions that will help them observe and discover and correct their own misconceptions. Learners allowed to design and conduct investigation through activities, under explore phase had one (1) count and this is an indication that even if teachers have agreed that they use the inquiry

method during their lessons, learners were not frequently allowed to handle apparatus and conduct investigations on their own.

Pedagogical strategies used in daily teaching

In order to determine the teachers' number of times they use pedagogical strategies, the observation checklist comprised of statements on the roles of teachers during instructions. The number of times for pedagogical strategies used in daily teaching is shown in Table 4.

Table 4: The number of times pedagogical strategies was used in daily teaching

Pedagogical Strategies used in daily teaching	**No. of times**
Classroom management	
Teacher creates conducive learning environment	10
Teacher monitors the whole classroom	10
Teacher praises learners for their contribution and involvement	8
Teacher provides positive feedback	8
More time was spent on learning activities	9
Teachers corrects behaviour immediately	10
Knowledge of inquiry method	
Teacher knows when and how to apply which teaching method	8
Learners are encouraged to interact and communicate with each other during their investigations or during class discussions	7
Teacher prepares the learning environment where learners can discover new knowledge	10
Teacher serves as guide and provides learning activities for learners' investigations	10
Teacher provides rich learning activities that are related to learners' lives	8
Teacher makes use of appropriate teaching and learning aids during the lesson	10
Teacher encourages learners to use correct scientific language. e.g. ''measuring cylinder'', **not** just a cylinder	8
Teacher encourages learners to work in groups or in pairs	7

Teacher presents the materials in a logic manner	9
Implementation of the lesson	
Teacher allows learners to handle materials (where applicable)	9
Learners are allowed to use different methods to solve problems	7
Learners are asked to give more than one solution to the problem	7
Learners are encouraged to answer others learners' questions	7
Teacher emphasises main points of the lesson	10
Teacher corrects learners' misconceptions	8
Teacher gives immediate feedback to the learners after presenting their findings	6
Teacher encourages learners to reflect on the learnt content	9
Evaluation of inquiry activities	
Learners' assessment activities are linked to the syllabus objectives	10
Teacher marks all learners' assessment activities	8
Teacher keeps record of learners 'assessment marks	8

The data in Table 4 shows that with regards to classroom management, six lessons observed more time was spent on learning activities consistently, compared to other behaviours. Furthermore, in seven out of ten observed lessons, teachers frequently encouraged learners to ask and answer questions. Results furthermore indicated that only in three out ten lessons where teachers allowed learners to handle materials and seven out of ten lessons the researcher observed that learners' assessment activities were linked to the syllabus objectives.

Furthermore, results that emerged from the observation checklist indicated that teachers implemented strategies related to the inquiry method although not all the listed behaviours were displayed more frequently. This finding coincides with Mamba and Putsoa (2018) view that even though teachers, in theory, identify the best pedagogical strategies, in practice they spend considerably more time using the lecture method at the expense of other strategies. The use of ineffective pedagogical strategies in the expense of the effective ones suggests the existence of some

pressures that prevent the teachers from utilising what they know to be essential for effective teaching. Based on the observation of the researcher, school coded C did not have science laboratories. From this observation one can conclude that the fact that the school has no laboratory could also discourage teachers from teaching practical activities and investigations which were supposed to be carried out in the laboratory.

4.4 How Physical Science teachers practice pedagogical knowledge through inquiry method during instruction

This theme is based on research question two: How do Physical Science teachers practice their pedagogical knowledge through inquiry method to teach Ordinary level?

Based on this theme, the researcher aims to find out what knowledge and skills Physical science teachers use to implement inquiry method during instructions. The researcher also aims to find out what knowledge and skills teachers require in order to implement inquiry method. The researcher also aims to find out what knowledge of skills teachers require to transfer the subject content to the learners in the meaningful way. Results under this theme were presented based on the findings emerged from the all three instruments. Findings from interviews based on knowledge of skills teachers required to implement the inquiry method

Have you ever received training on how to use inquiry method? When and how was it provided?

During an interview participated teachers were asked whether they have received teachers' training or in - service training on inquiry method.

Teacher T1 responded as follows: *Yes, more than ten yes ago. It was part of the University training when it was integrated in the curriculum.*

Teacher T2 responded: *Not really.*

Teacher T3 replied as follows: *Yes, well, at the university as well as workshops.*

Teacher T3 replied as follows: *I would not say no, I will say yes. It was the training at the college of education in the module called Education Theory and Practice.*

Teacher T4 responded: *Yes. Throughout my studies when I was at the university all those where incorporated in general teaching methodologies.*

Teacher T5 replied by saying: *To me personally I will say it was adequate or it was sufficient enough.*

Did the training meet your expectations?

Do you think that you will need further training on inquiry method? (Yes)/ (No)

If yes, which aspects do you suggest training should focus on?

In a follow up question in an interview, teachers were also asked if the training they received was adequate or still needed training and they were also asked to suggest some aspects the training should focus on. Teachers' responses were presented as follows:

Teacher T1 replied: *I must say, it was adequate, but the environment in which I am teaching now is completely different with new policies coming in. you can say it was*

adequate from the beginning or from the time when we were in training but now with the new environment and new policies, I see that there are challenges.

Teacher T3 replied as follows: *I would not say no, I will say yes. It was the training at the college of education in the module called Education Theory and Practice and those modules that we covered in the college of Education. So it was all integrated and had different teaching methods that were taught. We were also tested on how best we can use them. Because we were sent on SBS to put best in practice yes we did, it's just that we knew the different teaching style and one had to apply all three different teaching methods in one lesson presentation. So it was adequate because if it was not I think we could not even have graduated.*

Teacher T4 responded: *All the methods where incorporated in education theory and practice as a subject. So the inquiry part was also one of the methods that we were taught when approaching learners in the classroom. There were different ways or methods and inquiry methods was one of them was part of the training that was given to us. So we were prepared how to approach the method when dealing with the learners in the classroom setup.*

Teacher T5 replied: *The inquiry part was also one of the methods that we were taught when approaching learners in the classroom. There were different ways and the inquiry method was one of them during our teacher training. Thus, we were prepared on how to approach a situation when dealing with learners in the classroom setup. To me personally, it was adequate because as a teacher now, I do not face any difficulties because of the background I have with regards to these*

methods. Even with the little orientation that was done, realise I am more prepared to enter any situation or to approach any classroom in any manner.

All four teachers T1, T3, T4, and T5 have indicated that the training they have received during teachers' training was adequate, however, they suggested that they still needed training on the inquiry method. All teachers indicated that they still needed training on the inquiry method, but they did not indicate the aspects that the training should focus on. The fact that teachers have admitted that the training they have received on the inquiry method was adequate is evidence that teachers have some basic skills required to implement the method. However, there is a need to address the challenges that hinders the effective implementation of the inquiry method in the teaching of Physical Science and this can be addressed by providing continuous professional development in service training of teachers.

What type of activities and tasks do learners carry out when using the inquiry teaching method?

Teachers were asked to name the learning activities which they used during the inquiry method. Teacher T3 indicated that during the inquiry instructions learners used physical objects for example in measuring, constructing and using models. Other activities that learners used as noted by teacher T5 include designing projects and working in groups. Teacher T2 and T4 indicated that classroom exercises and worksheets were used during the inquiry lesson. The type of classroom activities carried out by learners during the inquiry method may depend on several factors that

determine teachers' choice of teaching methods when presenting their lessons as well as on the basic competencies in the syllabus.

4.5 Challenges Faced by Physical Science teachers as they use the inquiry method

This theme is based on research question three: What are the challenges faced by Physical Science teachers as they use the inquiry methods?

Under this section the researcher aimed at investigating the obstacles that Physical Science teachers encountered when implementing the inquiry method. Data in this section was gathered using questionnaires and interviews. Results emerging from questionnaires were presented first followed by results from interviews.

4.5.1 Findings from the interviews based on the challenges

The data presented under this theme emerged from teachers' responses based on questions from the interview guides about the challenges that Physical Science teachers experienced when using the inquiry method.

What are the challenges that you experienced when using inquiry method?

Teachers were asked in an interview to state the challenges they are facing when using inquiry method.

Teacher T1 responded that:

The challenges are that we are dealing with learners with different abilities some are faster learners, some are slow learners, and slow learners may not catch up, or may be their speed of catching may be that slow as it eventually means that you spend

much time at one stage. We also have learners with disabilities, like learners who have hearing problems. You have first to communicate to the translator, and translator communicates to the learner and you know that information may get lost or instruction may get distorted in the process of translation. Even if the proper scientific terminologies are used instructions may get distorted or may not conveyed or translated as it should be. In their own, also they own way of interpreting information so there is a lots of information lost.

Teacher 2 replied saying:

Inquiry methods are time consuming, because it takes time for learners to participate to give information that you are looking for. Discipline also can be a problem as some learners may take an opportunity to share different ideas that are related to the subject but in a way that a little bit disturbing.

Teacher T3 responded as follow:

Learners sometimes do not focus especially when you are using the question and answer method. Learners do not really focus on the subject content, and want to explain more things that are not related to their subject content; which sometimes bring some more disruption in class.

Teacher T4 replied that:

Learners do not have freedom of expression. They lack confidence, yet in inquiry teaching they need to be vocal as it is more a practical method of teaching. If one cannot express themselves, it creates a barrier; hence, learners have to be confident. The problem is that most learners are not confident because of non-exposure on different level.

Teacher T5 replied by saying:

The common one is lack of expression by learners. Learners cannot express themselves due to language barrier and fear. They are afraid to give answers in Science because they think they will answer them wrong, not knowing that any answer may be regarded as correct, depending on how you put it. Lack of self-confidence affects the learners. Sometimes you find a learner writing the correct answer and scratching out that answer and write something else and that boils down to the part of not having the insightful content of the subject. They do not think that what they read from the book is sufficient enough to support what they are giving as an answer.

Results from this study indicated that teaching learners with different learning abilities hindered the implementation of the inquiry method during instruction. Using the inquiry method with learners of different learning abilities might not be effective due to the fact that slow learners may not understand content and carry out tasks at the same pace as the faster learners. Teacher T2 added that the inquiry method is time consuming and as a result, it takes time for learners to participate and give their contribution to the topic under discussion. One participant (teacher T3) indicated that involving learners during the inquiry method caused chaos in the classroom because in the process of asking and answering questions, learners brought in unnecessary ideas and this caused a disruption in class. Moore and Hansen (2012) stated that although actively engaged learners generally caused few problems, the inquiry method appeared to be an undisciplined process in which little learning took place. One teacher T2 articulates that the inquiry method is time consuming because it takes time for learners to participate and give information that the teacher is looking for.

In addition, teacher T4 and T5 noted that one main challenge that teachers face in implementing the inquiry method is that learners' lacked expression and self-confidence. Learners are not free to give their views even if they are correct and have fear that their fellow learners may laugh at them. In some cases, learners were not willing to talk because of fear to give wrong pronunciations of some words. Another obstacle to active participation of learners during inquiry instruction as indicated by teacher T4 is learners' lack of exposure to science related events. Lack of exposure to science related events hinder learners to participate and apply science concepts and principles to everyday life.

4. 6. Discussion of Results

This study investigated the pedagogical knowledge and practice of the inquiry method by Physical Science teachers at the selected secondary schools in the Khomas educational region, in Namibia. The discussions of the results are presented as follows:

- Physical Science teachers' perceptions about pedagogical knowledge of inquiry method;
- How Physical Science teachers practice their pedagogical knowledge through the inquiry method; and
- The challenges faced by the Physical Science teachers when practicing the inquiry method.

Physical Science teachers' perceptions about pedagogical knowledge of inquiry method

The findings that emerged from research question no. 1 revealed that all the teachers who participated in this study used the inquiry method. However, the effectiveness of the use of the inquiry method may depend on other factors including the knowledge that teachers require in implementing the inquiry method. These findings support DiBiese and McDonald (2015) argument that science teachers feel that they do not have the requisite background knowledge to effectively implement inquiry method. Hence, extensive training is needed to prepare teachers to teach using the inquiry method. Adopting a similar position, Comley (2009); Duran and Duran (2004) argue that teachers understand the importance of inquiry method as far as the goals of science education are concerned, but they lack knowledge and strategies to design and implement effective inquiry - based lessons.

In response to the question if teachers use inquiry method and to explain how they use this method, all the participants (teachers) responded that they use the inquiry method to interact with learners and to get them involved in the topics under discussion and in the learning process. These results are in line Adofo (2017) findings that inquiry teaching has a potential to purposefully awaken and sustain learners' interest and promotes positive attitudes of learners in learning science. Meaning that, by using inquiry method teachers can assess learners' prior knowledge about the topic for the lesson; find out what they knew already and what they do not know as well as identifying misconceptions among the learners about a specific topic.

The data in Table 4 shows that with regards to the six lessons that were observed, more time was spent on learning activities consistently; while seven out of ten observed lessons, the teachers frequently encouraged learners to ask and answer questions. These results are in accordance with NRC (1996) as cited in DiBiase and MacDonald (2015) who stated that learners should be actively involved in their own learning and that they must learn to take responsibility for that learning. It is therefore suggested that learners should learn to generate questions, make predictions and provide valid and supportable evidence rather than merely concentrate on acquiring knowledge through memorisation of facts.

How Physical Science teachers practice their pedagogical knowledge through the inquiry method

One of the questions in an interview session asked the participants if they have received training on inquiry method during their teachers' training and whether the training was adequate or they still need further training. Four teachers indicated that they have received the training, however all five teachers indicated that they still need training on inquiry method. Supporting these results Dudu and Vhurumuku (2012) stated that 'it is important for Science Teachers Education Programme (both pre and in – service) to equip teachers with requisite knowledge and skills for them to engage learners in authentic inquiry activities (p. 582). The fact that science teachers have received training on inquiry method during teachers' training does not necessary mean that the knowledge and skills acquired thereof is adequate. Like Dudu and Vhurumuku (2012), Manditereza (2016) Alake-Tuenter et al. (2012) and Lederman (2007) maintain that continuous professional development should be provided to keep teachers up to date with the changing curriculum and subjects' syllabi.

On the questionnaire items, teachers were also asked to name the learning activities which they use during the inquiry method. The results indicated that teachers use various learning activities during inquiry method such as: learners using physical objects in doing measurements, constructing and using models, designing projects and working in groups as well as classroom exercises and worksheets. Supporting the results Ramnarain (2014), citing the Department of Basic Education (2011) points out that "in order for learners to competently engage in inquiry, they need to possess well developed investigative skills such as classifying, communicating, measuring, designing an investigation, drawing and evaluating conclusions, formulating models, hypothesising, identifying and controlling variables, inferring, observing and comparing, interpreting, predicting, problem-solving and reflective skills" (p. 181).

The teacher's choice of learning activities to be used during a specific lesson presentation mainly depends on several factors such as: the basic competencies in the syllabus, class size and availability of materials and resources. For these reasons, teachers employed different learning activities during their lessons where by some activities might not be part of the inquiry method. However, DiBiase and McDonald (2015) argue that issues such as class size, accountability curricular demands and administrative support are perceived as constraints impeding the use of inquiry method.

DiBiase and MacDonald (2015) pointed out that the inquiry method should prepare learners to be able to propose questions, make observations, design and conduct investigation, use appropriate tools and techniques in order to gather and analyse data, utilise critical thinking skills, use evidence to develop explanations and

predications and communicate this information. Adding to this view, the results further indicated that only three out of ten lessons teachers allowed learners to handle materials; while seven out of ten lessons the researcher observed that learners' assessment activities were linked to the syllabus objectives. These results however seem to contradict Flick (2000) as cited in Poon, Lee, Tan and Lim (2012) views that there is no strong arguments that every inquiry classroom should look the same since inquiry method has to be adapted for diverse classroom to meet the learners' needs. This means that the type of classroom activities carried out by learners during the inquiry method may depend on several factors that determine teachers' choice of teaching methods when presenting their lessons as well as on the basic competencies in the syllabus.

Challenges faced by Physical Science teachers when practicing the inquiry method.

The last research question was based on the challenges Physical Science teachers faced when practicing inquiry method during their lessons. In the questionnaire and during the interviews, Physical Science teachers were asked to describe the challenges that they face when practicing inquiry method during their daily lessons, namely: Learners' lack of expression and self-confidence. Learners are not free to give their views even if they are correct and have fear that their fellow learners may laugh at them. In some cases, learners were not willing to talk because of fear to give wrong pronunciations of some of the difficult words. The results also revealed that lack of exposure to science related events hinder learners to participate and apply science concepts and principles to everyday life. Supporting these findings, Ural (2016); Nakanyala (2015); and Kurumeh, Jimin and Mohammed (2012) highlighted that learners' poor background of Physical Science and English proficiency could

affect their attitudes towards the subject; hence their involvement and participation during instructions might be negatively affected. Lack of self-expression and confidence among the learners remain a serious challenges in the teaching and learning process which limits some learners from participating in learning activities. DiBiase and MacDonald (2015) noted that learners in an inquiry class learn to work effectively in groups and that they open their work to public critique in the classroom, throughout the school and occasionally in the community.

The findings also revealed that teachers indicated that inquiry method is time consuming, as learners may take more time to give their responses. Adofo (2017) as well as DiBiase and McDonald (2015) support these findings that inquiry teaching is time consuming because lessons take too long to develop. The participants in this study also indicated that involving learners during the inquiry method caused chaos in the classrooms because in the process of asking and answering questions, learners brought in unnecessary ideas and this may cause disruption in the classroom. These findings support DiBiase and McDonald (2015) and Dhurumraj (2013) who raised a concern that learners tend to mismanage their time when inquiry is being implemented in their classes and as such more time is spent on disciplining learners rather than teaching and learning.

The findings from this study on the challenges Physical Science teachers are facing when practicing inquiry method were more on external factors, indicating that the teachers may need more pedagogical knowledge and skills training on how to implement inquiry method within the diversity of their classrooms.

4. 7. Summary

This chapter presented findings of this study emerging from questionnaires, observation checklists and interviews. Findings revealed that all teachers who participated in this study use the inquiry method during their lessons. Although findings also indicated that teachers use the inquiry method during instructions, results emerging from questionnaires, interviews and observation checklists shows a discrepancy in the frequency of using the inquiry method and other activities used during instruction. Findings from this study revealed the challenges teachers faced when using the inquiry method such as: the method is time consuming, inadequate resources, overcrowded classrooms and lack of self-expression and confidence among learners. Furthermore, other impediments that were identified that limited the use of the inquiry method include lack of skills and knowledge on how to design and conduct inquiry lessons in large classes with learners of diverse learning abilities. Findings from this study have also shown that teachers are in need of training on the inquiry method and they are well acquainted with the benefits of the method as far as the academic performance of learners is concerned.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMENDATIONS

5.1 Introduction

This chapter presents the summary, conclusion and recommendations based on the findings from this study. This study investigated Physical Science teachers' pedagogical knowledge and practices of inquiry teaching at secondary school level, Khomas education region in Namibia. Finally, areas for further research are also identified to expand on this study.

5.2 Summary

The main aim of this study was to investigate Physical Science teachers' pedagogical knowledge and practices of inquiry teaching at secondary school level, in the Khomas education region in Namibia. The study was guided by three research questions as indicated below:

1. What are Physical Science teachers' perceptions about pedagogical knowledge of inquiry method to teach Ordinary level?
2. How do Physical Science teachers practice their pedagogical knowledge through the inquiry method to teach Ordinary level?
3. What are the challenges Physical Science teachers face as they use the inquiry method?

This study employed a qualitative, exploratory research design to explore the pedagogical knowledge and practices of Physical Science teachers regarding the

inquiry method. Extreme case sampling was used to select two secondary schools that have been among the top ten performing schools and other two secondary schools that have been at the bottom of the rank in the Khomas education region for the NSSCO Physical Science results of the year 2018. Purposive sampling was then used to select three Physical Science teachers who have taught Physical Science for more than three years. Only three secondary schools took part in this study: the second top performing and the two bottom performing schools, as the school Principal of the first top performing school declined for the school to take part in this study. Among the three participated schools, only one teacher from the second bottom performing school agreed to take part and two teachers from the each of the other two schools. Hence, the total sample of this study consisted of three (3) participants.

The two research instruments used were: observation checklists, and structured interviews (see Appendices G to I). Data was collected through lesson observations and followed by structured interviews. Each teacher was first observed through two different lessons. Thereafter, participants were interviewed individually on the following day. After data collection and coding, qualitative thematic analysis methods were employed to analyse and interpret the data for this study.

The study findings revealed that all the Physical Science teachers who participated in this study used the inquiry teaching method when presenting their lessons. The teachers used the inquiry method in order to assess learners' prior knowledge as well as measuring their level of understanding especially when starting a new topic and throughout the lesson to assess learners' understanding. Furthermore, results

indicated that teachers used questions and answers during the inquiry method to arouse learners' interests in order for them to participate and get involved in answering and asking questions regarding specific topics. Based on the findings of this study, teachers indicated that they used discussion and questions and answers teaching method more frequently as these methods take less time and motivate learners to be actively involved. The inquiry method make learners to participate in the lesson compared to experiments and projects teaching method. Furthermore, teachers indicated that through the discussion method, a teacher can identify learners' weakness and strengths, thus providing support and guidance where possible. Although the results from this study revealed that the experimental method was not used frequently as discussions and questions and answers methods, two teachers indicated that using the experiment method gives teachers the room to observe learners' practical skills and enable teachers to correct mistakes done by learners on time.

The findings that emerged from this study have shown that teachers were familiar with the steps of inquiry method whereby they engage learners by asking questions to assess their prior knowledge about the topic under discussion. Another inquiry step teachers used during instruction is 'explain' where by learners are expected to explain their understating of the topic. However findings show that the 'explore' step was not used frequently like other steps of inquiry as only one teacher indicated that he used it always. Four participants indicated that they have received adequate training on the inquiry method. However, they indicated that they needed training on inquiry teaching.

Finally, this study sought to find out the challenges Physical Science teachers faced in implementing the inquiry method during instructions. The results indicate the following:

- Lack of science resources and materials required to execute practical activities limits the use of inquiry method.
- Teachers indicated that inquiry related teaching and learning activities such as peer tutoring, group work, projects and experiments require a lot of time and energy taking into considerations of class size and the number of learners per class. Findings from this study also revealed that some steps of inquiry such as explore and elaborate were not used more frequently as it takes more time for learners to start participating when this method is used, furthermore learners are not really open up to discuss subject content.

- Teaching learners with different learning abilities hinder the implementation of inquiry method during instruction.
- Learners lack of expression and self-confidence. Other obstacle to active participation of learners during inquiry instruction is lack of exposure of learners to science related events.

5.3 Conclusions

Based on the results from this study it is evident that majority of the teachers who participated in this study were well acquainted with inquiry teaching method. It can be thus concluded that participants are aware of the pedagogical strategies and steps related to inquiry teaching, although there are obstacles that hinders the effective implementation of inquiry teaching in science classrooms.

The findings from this study also revealed that the reasons why in most cases teachers fail to use the inquiry method is due to several challenges faced. Therefore, there is a need to address these challenges that hinders the implementation of inquiry methods during instructions. Hence, teachers commented that they needed to be trained on how to implement the inquiry method in large classrooms with learners of diverse learning abilities. Continual Professional Development training to be provided should be aimed at assisting teachers to design and prepare inquiry activities that will involve all learners and reduce indiscipline in the classroom.

5.4 Recommendations

Based on the findings from this study, the following recommendations are proposed in order to promote the implementation of inquiry teaching in Physical Science classrooms:

- It is evident that teachers use inquiry teaching less frequently due to several challenges they are faced with, such as teachers' lack of skills on how to design and plan inquiry teaching activities and lack self-confidence and self-expression among learners. Science teachers should be provided with continuous profession development training to equip them with the necessary skills and expertise on how to use design and prepare inquiry activities that attract learners' attention; so as to arouse their curiosity to study Science. Science teachers should ensure that all recommended practical activities and investigations prescribed in the syllabus are demonstrated to learners at all grades.
- Results from this study indicated that inadequate resources and lack of laboratories negatively affect teachers' implementation of inquiry teaching in

science classrooms. Therefore, the Ministry of Education, Sport and Culture should ensure provision of all required resources and facilities to enhance the effective teaching of Science.

- Based on inadequate resources, schools are advised to organise fundraising events in order to generate funds to buy science materials. Furthermore, schools should also try to approach private companies for donations to construct laboratories, build more classrooms and buying supplementary materials for their laboratories, in order to meet the government halfway.
- Findings from this study indicated that Physical Science teachers need support from the HODs and Subject advisory teachers concerning the use of the inquiry method. Hence, it recommended that HODs and Subject Advisory teachers should organise in-house trainings for their teachers. They should invite an expert persons in Physics or Chemistry from any institution of higher learning such as the University of Namibia (UNAM) and Namibia University of Science and Technology (NUST) to facilitate the training workshops on specific topics on the request of the teachers. Participants also recommended that teachers' training should focus on practical investigation, presenting lessons on a specific topic as well as on assessing learners for continuous assessment and how marks are allocated to the answers when marking learners' assessment tasks.

The National Institute for Educational Development (NIED), in conjunction with the Ministry of Education, Art and Culture should provide continuous professional development training for both novice and experienced teachers to ensure that all the teachers are well acquainted with new trends in the revised curriculum for the senior secondary ordinary level education.

5.5 Recommendations for Future Studies

This study investigated Physical Science teachers' pedagogical knowledge and practices of inquiry teaching at secondary school level, Khomas education region. Therefore findings from this study cannot be generalised to all other schools that are not in the Khomas education region. Hence, a similar study can be carried out in other educational regions to investigate Physical Science teachers' pedagogical knowledge and practices of inquiry teaching in other regions in Namibia in order to generalise the findings. This study is qualitative in nature; therefore, a quantitative study should be conducted to assess the effect of Physical Science teachers' pedagogical knowledge and practices on learners' academic performance in Physical Science. A comparative study should be also conducted to investigate teachers 'pedagogical knowledge and practices in other subjects, in order to get more understanding of teachers' PK and practice in different subjects.

REFERENCES

Adofo, S. (2017). *Teachers' perceptions about inquiry in science education*. (Master Thesis). University of Eastern Finland. Retrieved from: http://epublications,uef.fi/pub/urnndfiuef- 20170914/urnnbnfiuef 20170914.pdf.

Akama, M. K. (2015). *Instructional strategies and their influence on pupils' academic performance in science subject at primary schools in Ruiru sub-county*, Kiambu. County, Kenya. Retrieved from: https://ir-library.ku.ac.ke/bitstream/handle/123456789/14501/instructional

Aksela, M. K. (2011). *Engaging students for meaningful chemistry learning through micro computer-based Laboratory (MBL) inquiry*. Retrieved from: http://scq.iec.cat/scq/index.html

Aleka-Tuenter, E., Bieman, H. J. A., & Tobic, H. (2012). Inquiry-based science education competencies of primary school teachers: A literature study and critical review of the American National Science Education Standards. *International Journal of Science education*. *34*(17), 2609-2640. DOI: 10.1080/09500693.2012.669076

Ary, D., Jacobs, L. C., Sorensen, C. K., & Walker, D. A. (2014). *Introduction to research in education*. (9th ed). United States, Wadsworth: Wadsworth Cengage Learning.

Bell, C. et al. (2001). Enhancing teachers' knowledge and use of inquiry through environmental science education (2001). *Journal of Science Teacher Education, 14*(1), 49 – 71.

Ben-Peretz, M., & Shachar, M. (2012). The role of experimental learning in holocaust education. *Social and Education History, 1*(1), 527. DOI: 10.4471/hse.2012.01

Bozkurt O., & Kaya, O. N. (2010). Teaching about ozone layer depletion in Turkey: Pedagogical content knowledge of science teachers. *Public Understand Science, 17*(2), 261-76. DOI: 10.1177/0963662506071787. PMID: 19391381.

Brodie, B., & Sanni, R. (2014). We won't know it since we don't teach it: Interactions between teachers' knowledge and practice. *African Journal of Research in Mathematics, Science and Technology Education Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE), 18*(2), 188-197.

Bybee, R. W. (2014). The BSCS 5E instructional model: Personal reflections and contemporary. *Science and Children, 51*(8), 10-14.

Cardak, O., Dikmenli, M., & Saritas, O. (2008). Effect of the 5E instructional model in student success in primary school 6th year circulatory system topic. *Asia-Pacific Forum on Science Learning and Teaching,* 9(2), 85 – 13.

Çepni, S., & Şahin, C. (2012). Effect of different teaching methods and techniques embedded in the 5e instructional model on students' learning about buoyancy force. *Eurasian Journal of Physics and Chemistry Education, 4*(2), 97-127.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education.* (7th ed). London: Routledge Falmer.

Comley, M. (2009). The inquiry-based science pedagogy debate. *Learning Landscapes, 2*(2), 155-167. Retrieved from: https://doi.org/10.36510/learnland.v2i2.301

Creswell, J. W. (2014). *Qualitative inquiry and research design: Choosing among the five approaches.* (4th ed). Los Angeles: Sage.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches.* (3rd ed). London, Los Angeles. Washington DC: Sage.

Creswell, J. W. (2012). *Educational research: Planning, conducting and evaluating quantitative and qualitative research.* (4th ed). Boston: Pearson Education.

Dagys, D. (2017). Theoretical inquiry-based learning insights on natural science education: From the source to 5E model. *Pedagogika, 126*(2), 83–98.

DiBiase, W. & McDonald, J. R. (2015). Science teachers' attitudes toward inquiry – based teaching and learning. Clearing House: *A Journal of Educational Strategies, Issues and Ideas, 88(*2), 29 – 38.

Directorate of the National Examinations and Assessment (DNEA). (2014). *National and regional distribution of symbols November 2014 NSSC (Gd 12) - ordinary level full time*. Retrieved from: http://www.dnea.gov.na/document/

Directorate of the National Examinations and Assessment (DNEA). (2015). *National and regional distribution of symbols November 2015 NSSC (Grade 12) - ordinary level full time*. Retrieved from http://www.dnea.gov.na/document

Directorate of the National Examinations and Assessment (DNEA). (2016). *National and regional distribution of symbols November 2016 NSSC (Gd 12) - ordinary level full time*. Retrieved from: http://www.dnea.gov.na/document/

Directorate of the National Examinations and Assessment (DNEA). (2017). Circular*: DNEA 22/2017. NSSCO Senior Level examination 2017.* Windhoek: Ministry of Education.

Directorate of the National Examinations and Assessment (DNEA). (2017). *National and regional distribution of symbols November 2017 NSSC (Gd 12) -ordinary level full time*.

Directorate of the National Examinations and Assessment (DNEA). (2018). Circular*: DNEA 22/2018. NSSCO Senior Level examination 2018.* Windhoek: Ministry of Education.

Directorate of the National Examinations and Assessment (DNEA). (2018). *National and regional distribution of symbols November 2018 NSSC (Gd 12) - ordinary level full time*. Retrieved from: http://www.dnea.gov.na/document/417550/417898/National

Dhurumraj, T. (3013). *Contributing factors to learners 'poor performance in Physical Science in Kwazulu-Natal province with special reference to schools in the Pinetown*

District. (Master Dissertation). University of South Africa. Retrieved from: http://hdl.handle.net/10500/13343

Dudu, W. T. & Vhurumuku, E. (2012). Teachers' practices of inquiry when teaching investigations: A case Study. *Journal of Science Teachers Education*, *23*(6), 579 – 600. Retrieved from: http://www.jstor.org/stable/43156664.

Duran, L. B., & Duran, E. (2004). The 5e instructional model: a learning cycle approach for inquiry based science teaching. *The Science Education Review*, *3*(2), 49-58. Retrieved from: https://files.eric.ed.gov/fulltext/EJ1058007.pdf

Eimuhi, J. O., & Eimuhi, K. E. (018). Equipping teachers with learner-centred pedagogical skills. *Journal of Emerging Trends in Educational Research and Policy Studies. 9*(4), 138-147. Retrieved from: https://journals.co.za/content.journal/10520/EJC-11e8b3f809

Gillies, R. M., & Nichols, K. (2014). How to support primary teachers' implementation of inquiry: teachers' reflections on teaching cooperative inquiry-based science. DOI 10.1007/s11165-014-9418

Grangeat, M. (2016). Dimensions and modalities of inquiry-based teaching understanding the variety of practices and education inquiry. *Education Inquiry, 7*(4). Retrieved from**:** https://doi.org/10.3402/edui.v7.29863

Guerriero, S. (2013). *Teachers' pedagogical knowledge and the teaching profession, background report and project objectives. Project Lead: Rationale and Policy Context*. Retrieved from: https://www.oecd.org/education/ceri/Background

Haimbangu, M. (2018). *Practices that help grade 12 learners to improve their performance in Physical Science: A case of Omusati region, Namibia*. (Master Thesis). Windhoek: University of Namibia. Retrieved from: http://repository.unam.edu.na/discover?fq=type_filter%3Athesis|||Thesis

Halim, L., Abdullah, S. I. S., & Meerah, T., S., M. (2014). Students' perceptions of their science teachers' pedagogical content knowledge. *Journal of Science Education and Technology, 23*(2), 227-237. Retrieved from: https://www.jstor.org/stable/24019751

Harlen, W. (2013). *Assessment & inquiry-based science education: Issues in policy and practice.* Global Network of Science Academies (IAP) Science Education Programme. Retrieved from: https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Assessment+and+inquiry+based+science+education&btnG

Hudson, P. (2004). Towards identifying pedagogical knowledge for mentoring in primary science teaching. *Journal of Science Education and Technology, 13*(2), 215 – 228). Retrieved from: https://metprogram.com/p-content/uploads/2016//01/identifiying-pedagogical-knoledge.pdf

Hughes, J. (2005). The role of teacher knowledge and learning experiences in forming technology-integrated pedagogy. *Journal of Technology and Teacher Education, 13*(2), 277-302.

Hussain, A., Azeem, M., & Shakoor, A. (2011). Physics teaching methods: Scientific inquiry vs. traditional lecture. *International Journal of Humanities and Social Science, 1*(19), 269-276. Retrieved from: https://d1wqtxts1zle7.clountfront.net/4884365/2011_1H

Jimoyiannis, A. (2010). Developing a technological pedagogical content knowledge framework for science education: Implications of a teacher trainers' preparation programme. *Proceedings of Informing Science & IT Education Conference. 597 – 606*. Retrieved from: https://www.researchgate.net/profile/Athanassios_Jimoyiannis/publication/320655820

Justine, E., & Eromosele, E. K. (2018). Equipping teachers with learner-centred pedagogical skills. *Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS), 9*(4), 138-147. Retrieved from: https://hdl.handle.net/10520/EJC-11e8bf809

Kandjinga, J. (2019). *Investigating the grade 12 teachers' subject and pedagogical content knowledge of mathematics in some public schools in the Khomas Education Region, Namibia.* (Master Thesis). Windhoek: University of Namibia. Retrieved from: http://repository.unam.edu.na/discover?fq=type_filter%3Athesis|||Thesis

Kanyongo, G. Y., & Brown, L. I. (2013). Relationship between pedagogical strategies and teachers' content knowledge of Mathematics. *African Journal of Research in Mathematics, Science and Technology Education.17* (1-2), *106-112*.

Keys, C., W., & Bryan, L. A. (2001). Co-constructing inquiry-based science with teachers: essential research for lasting reform. *Journal of Research in Science Teaching, 38*(6), *631- 645*. Retrieved from: https://d1wqtxts1zle7.clountfront.net/11668948/15

Koehler, M. J., Mishra, P., & Cain, W. (2013). What is technological pedagogical content knowledge (TPACK)? *Journal of Education, 193*(3), 13-19.

Koehler, M. J., & Mishra, P. (2008). *Introducing technological pedagogical content knowledge (TPCK). AACTE committee on innovation and technology.* Retrieved from: http://journals.co.za.ezproxy.unam.edu.na.and technology.

Kurumeh, M. S., Jimin, N., & Mohammed, A. S. (2012). Enhancing senior secondary students' achievement in algebra using inquiry method of teaching in Onitsha Educational Zone of Anambra state Nigeria. *Journal of Emerging Trends in Educational Research and Policy Studies, 3*(6), 863-868. Retrieved from: https://journals-coza.ezproxy.unam.edu.na/docserver/fulltext/

Lederman, N. G. (2007). Nature of science: Past, present and future. In S. K. Abell & N. G. Lederman (Eds.). *Handbook of research on science education* (pp. 831-880). Mahwa, New Jersey: Lawrence Erlbaum Associates. Retrieved from: https://science.iit.edu/sites/science/files/elements/mse/hstp/pdfs/biology/

Liswaniso, P. (2019). *An investigation into the teaching of Biology and Physical Science practical works in senior secondary schools in the Zambezi region, Namibia*. (Master Thesis). Windhoek: University of Namibia.

Lin, J. L., Cheng, M. F., Chang, Y. C., Li, H. W., Chang, J. Y., & Lin, D. M. (2014). Learning activities that combine science magic activities with the 5E instructional model to influence secondary-school students' attitudes to science. *Eurasia Journal of Mathematics, Science and Technology Education*, *10*(5), 415-426.

Mamba, D., & Putsoa, B. (2018). Secondary school science teachers' knowledge and implementation of effective teaching strategies in high performing schools in Swaziland. *African Journal of Research in Mathematics, Science and Technology Education. 22*(1), *14-26.* Retrieved from: *http://journals.co.za.ezproxy.unam.edu.na.*

Manditereza, B. (2010). Improving quality of pedagogical practices in English as a language of learning instruction. *Interdisciplinary Journal,* 13(1), 40-52.

Martin, D. J. (2012). *Elementary science methods: A constructivist approach.* (2nd ed). International edition, Wadsworth: Cengage.

Marshall, J. H., & Sorto, M. A. (2012). The effects of teacher mathematics knowledge and pedagogy on student achievement in rural Guatemala. *Springer, 58,* 173-197.

Mkimbili, S. T., Tiplic, D., & Ødegaard, M. (2017). The role played by contextual challenge in practising inquiry-based science teaching in Tanzania secondary schools. *African*

Journal of Research in Mathematics, Science and Technology Education, 21(2), 211–221. https://dx.doi.org.ezproxy.unam.edu.na/10.1080/18117295.2017.1333752

Mokiwa, H. O. (2014). Exploring the teaching of Physical science through inquiry. *International Journal of Education Science, 7*(1), 21-27.

Mokiwa, H. O., & Nkopodi, N. (2014). Inquiry-based teaching in Physical Science: Teachers' instructional practices and conceptions. *Mediterranean Journal of Social Sciences,* 5(23), 1074-1085. Doi:10.5901/mjss.2014.v5n23p1074

Moore, K. D. (2012). *Effective instructional strategies: From theory to practice.* London: SAGE.

Moore, M. (2009)."Can Guided Inquiry Based Labs Improve Performance In Data Analysis And Conclusion Synthesis In Sixth Grade Life Science?" (Electronic Theses and Dissertation). Retrieved from: https://stars.library.ucf.edu/etd/4144

Muijs, D., & Reynolds, D. (2011). *Effective teaching: Evidence and practice.* (3rd ed). London: Sage Publications.

Mumba, F., Mejia, W. F., Chabalengula, V. M., & Mbewe, S. (2010). Resident scientists' instructional practice and their perceived benefits and difficulties of inquiry in schools. *Journal of Baltic Science Education,* 9(3), 187-195.

Nakanyala, J. M. (2015). *Investigating factors affecting the effective teaching of grade 12 Physical Science in selected secondary school in the Oshana Educational region in Namibia*. (Master Thesis). Windhoek: University of Namibia.

National Institute for Educational Development (NIED). (2009). *Namibia Senior Secondary Certificate: Physical Science Syllabus*. Okahandja: Ministry of Education.

National Institute for Educational Development (NIED) (2009). *Namibia Senior Secondary Certificate [NSSC]: Physical Science Syllabus Ordinary Level*. Okahandja: Ministry of Education.

National Research Council. (2011). *A Framework for K-12 science education: Practices, crosscutting concepts*. National Research Council, Board on Science Education, Committee on a Conceptual Framework for New K-12 Science Education Standards. Retrieved from: https://books.google.com/books/about/A_Framework_for_K_12_Science_Education.html?

Pearly, N. (2010). Teaching science through inquiry. *Proceeding of the Sunway Academic Conference. 31-37*. Retrieved from: https://eprints.sunay.edu.my/81/1/PDF

Poon, C. L., Lee, Y. J., Tan, A. L., & Lim, S. (2012). Knowing inquiry as practice and theory: Developing a pedagogical framework with elementary school teachers, *Research in Science Education, 42*(2), 303 – 327. Retrieved from: http://dx.doi.org/10.1007/s11165 - 010 - 9199-9

Ramnarain, U. (2014). Questioning the validity of inquiry assessment in a high stakes Physical Sciences examination. *Perspectives in Education, 32*(1). Retrieved from: http://www.perspectives-in-education.com

Ramnarain, U., & Schuster, D. (2014). The pedagogical orientations of South African Physical Sciences teachers towards inquiry or direct instructional approaches: *Research in Science Education*, *44*, 627-650.

Shamsuddin, N., Abdullah, N., & Yaamat, N. (2013). Strategies of teaching science using an inquiry based science education (IBSE) by novice chemistry teachers. *Social and Behavioural Sciences, 90*, 583-592.

Shulman, L. S. (2004). *The wisdom practice: Essays on teaching, learning and learning to teach. Knowledge and teaching: foundations of the new reform*. United States of America, New York: Josser – Bass.

Shulman, L. S. (2004). Knowledge and teaching: foundations of the new reform. In L. S. Shulman, & S. M. Wilson (Eds.), *The wisdom of practice: Essays on teaching, learning, and learning to teach (pp. 217e248).* San Francisco: Jossey-Bass (Original work published 1987).

Shulman, L. S. (1987). Knowledge and Teaching: Foundations of the New Reform. *Harvard Educational*, *57*(1), 1–23. Retrieved from: https://doi.org/10.17763/haer.57.1.j463w79r56455411

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14. Retrieved from http://links.jstor.org/sici?sici=0013-

Ssempala, F. (2017). *Science teachers' understanding and practice of inquiry-based instruction in Uganda*. Dissertation. Retrieved from: https://surface.syr.edu/etd

Tsakeni, M., Vandeyar, S., & Potgieter, M. (2019). Inquiry opportunities presented by practical work in school Physical science: A South Africa case study. *Gender Behaviour, 17*(3), 13722-13733. Retrieved from: https://journals.co.za/content/journal/10520/EJC-1975177d59

Wilcox, J., Kruse, J. W., & Clough, M. P. (2015). *Teaching science through inquiry: Seven common myths about this time honoured approach*. National Science Teachers Association. Retrieved from: https://www.jstor.org/stable/43683290

Wilkinson, D., & Birmingham P. (2003). *Using research instruments: A guide for researchers*. London: Routledge.

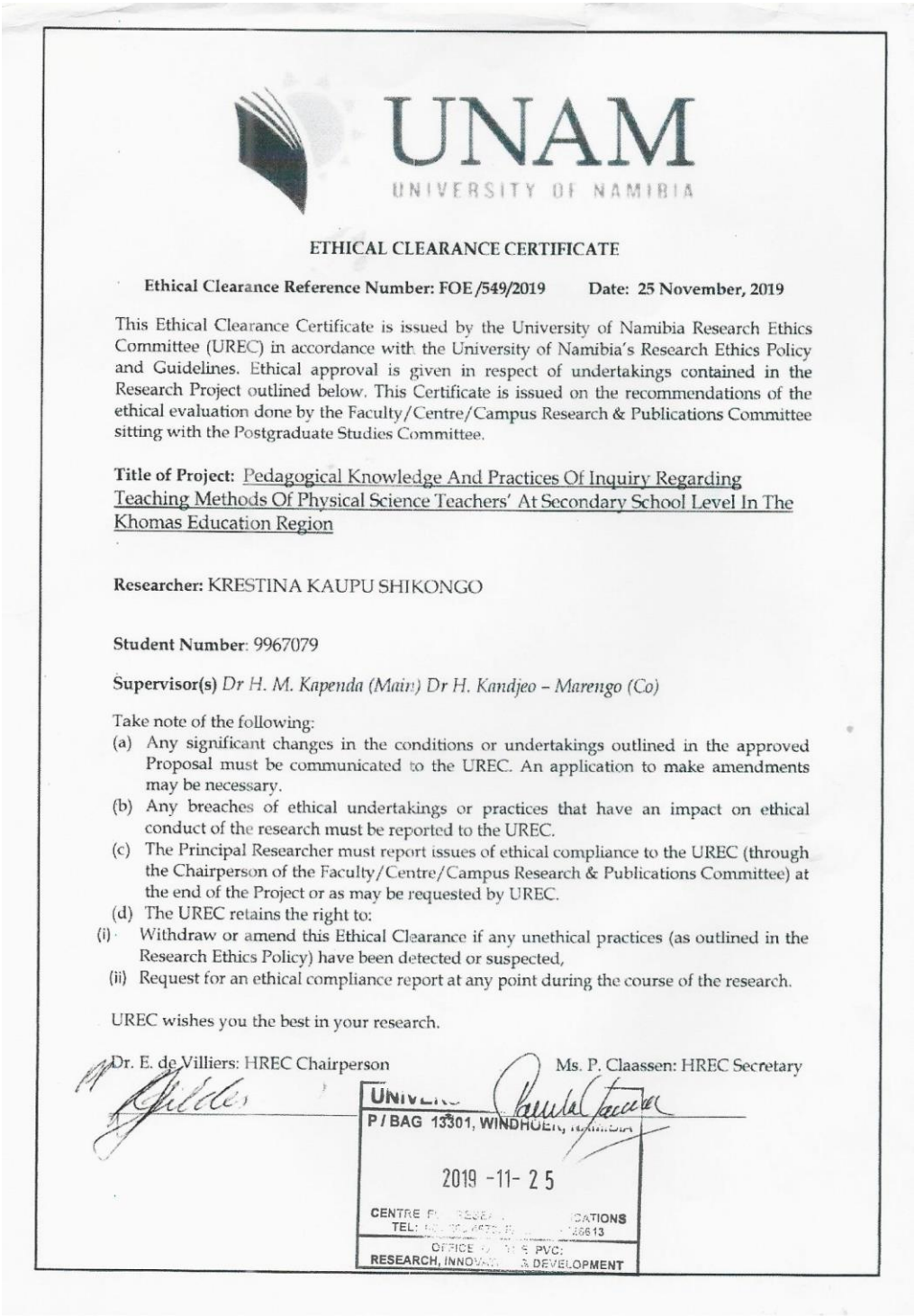
Yang, Y., Liu, X., & Gardella, J. A. (2018). Effects of professional development on teacher pedagogical content knowledge, inquiry teaching practices, and student understanding of interdisciplinary science. *Journal of Science Teacher Education, 29*(4), 263-282.

Yang, W., & Liu, E. (2016). Development and validation of an instrument for evaluating inquiry-based tasks in science textbooks. *International Journal of Science Education*, DOI: 10.1080/09500693.2016.1258499

Zeidler, D. (2002). Dancing with maggots and saints: Visions for subject matter knowledge, pedagogical knowledge and pedagogical content: Knowledge in science teacher education reform. *Journal of Science Teacher Education, 13*(1), 27-42.

APPENDIX A:

Permission Letter from the University of Namibia Research Ethics Committee



UNAM
UNIVERSITY OF NAMIBIA

ETHICAL CLEARANCE CERTIFICATE

Ethical Clearance Reference Number: FOE/549/2019 **Date: 25 November, 2019**

This Ethical Clearance Certificate is issued by the University of Namibia Research Ethics Committee (UREC) in accordance with the University of Namibia's Research Ethics Policy and Guidelines. Ethical approval is given in respect of undertakings contained in the Research Project outlined below. This Certificate is issued on the recommendations of the ethical evaluation done by the Faculty/Centre/Campus Research & Publications Committee sitting with the Postgraduate Studies Committee.

Title of Project: Pedagogical Knowledge And Practices Of Inquiry Regarding Teaching Methods Of Physical Science Teachers' At Secondary School Level In The Khomas Education Region

Researcher: KRESTINA KAUPU SHIKONGO

Student Number: 9967079

Supervisor(s) *Dr H. M. Kapenda (Main) Dr H. Kandjeo – Marengo (Co)*

Take note of the following:

(a) Any significant changes in the conditions or undertakings outlined in the approved Proposal must be communicated to the UREC. An application to make amendments may be necessary.
(b) Any breaches of ethical undertakings or practices that have an impact on ethical conduct of the research must be reported to the UREC.
(c) The Principal Researcher must report issues of ethical compliance to the UREC (through the Chairperson of the Faculty/Centre/Campus Research & Publications Committee) at the end of the Project or as may be requested by UREC.
(d) The UREC retains the right to:
(i) Withdraw or amend this Ethical Clearance if any unethical practices (as outlined in the Research Ethics Policy) have been detected or suspected,
(ii) Request for an ethical compliance report at any point during the course of the research.

UREC wishes you the best in your research.

Dr. E. de Villiers: HREC Chairperson

Ms. P. Claassen: HREC Secretary

UNIVERSITY OF NAMIBIA
P/BAG 13301, WINDHOEK, NAMIBIA
2019 -11- 25
CENTRE FOR RESEARCH, PUBLICATIONS
TEL: +264 61 206613
OFFICE OF THE PVC: RESEARCH, INNOVATION & DEVELOPMENT

APPENDIX B:

Letter requesting permission to the Executive Director

P. O Box 7862

Katutura

Cell: 0812707048
email: kaupushikongo@gmail.com

01st December 2019

Executive Director

Ministry of Education, Art and Culture

Private Bag 13186

Windhoek

Dear Madam

RE: Requisition for Permission to conduct Pilot study and the main research in secondary schools in the Otjozondjupa and Khomas Education Region during the year 2020 respectively

I am Krestina Kaupu Shikongo, (Student No. 9967079) a registered student at the University of Namibia pursuing a Master' s in Science Education. In fulfilment of the requirements for the completion of this degree, I am required to conduct a research project. I kindly request your office to allow me to use secondary schools in the Otjozondjupa and Khomas Education Region for the pilot study and for the main research during the year 2020 respectively.

The title of the research project is: **Pedagogical Knowledge and Practices of Inquiry Regarding Teaching Methods of Physical Science Teachers' At Secondary School Level In The Khomas Education Region.** The study will target a total of 8 NSSCO Physical Science teachers from four secondary school in Khomas Namely: Hage Geingob H.S, Academia H. S., Acacia H. S. and Cosmos H. S and two teachers will be drawn from each school. The study will be conducted through classroom observations, questionnaires and interviews of selected teachers per school. Information collected will be treated with confidentiality and will be used solely for the purpose of the research.

I hope findings for this research project will positively contribute toward improving Physical Science Teachers' pedagogical knowledge of inquiry in Khomas region. It will also help to discover problems facing Physical Science teachers in practising inquiry teaching methods, thus provide ways forward in solving such problems.

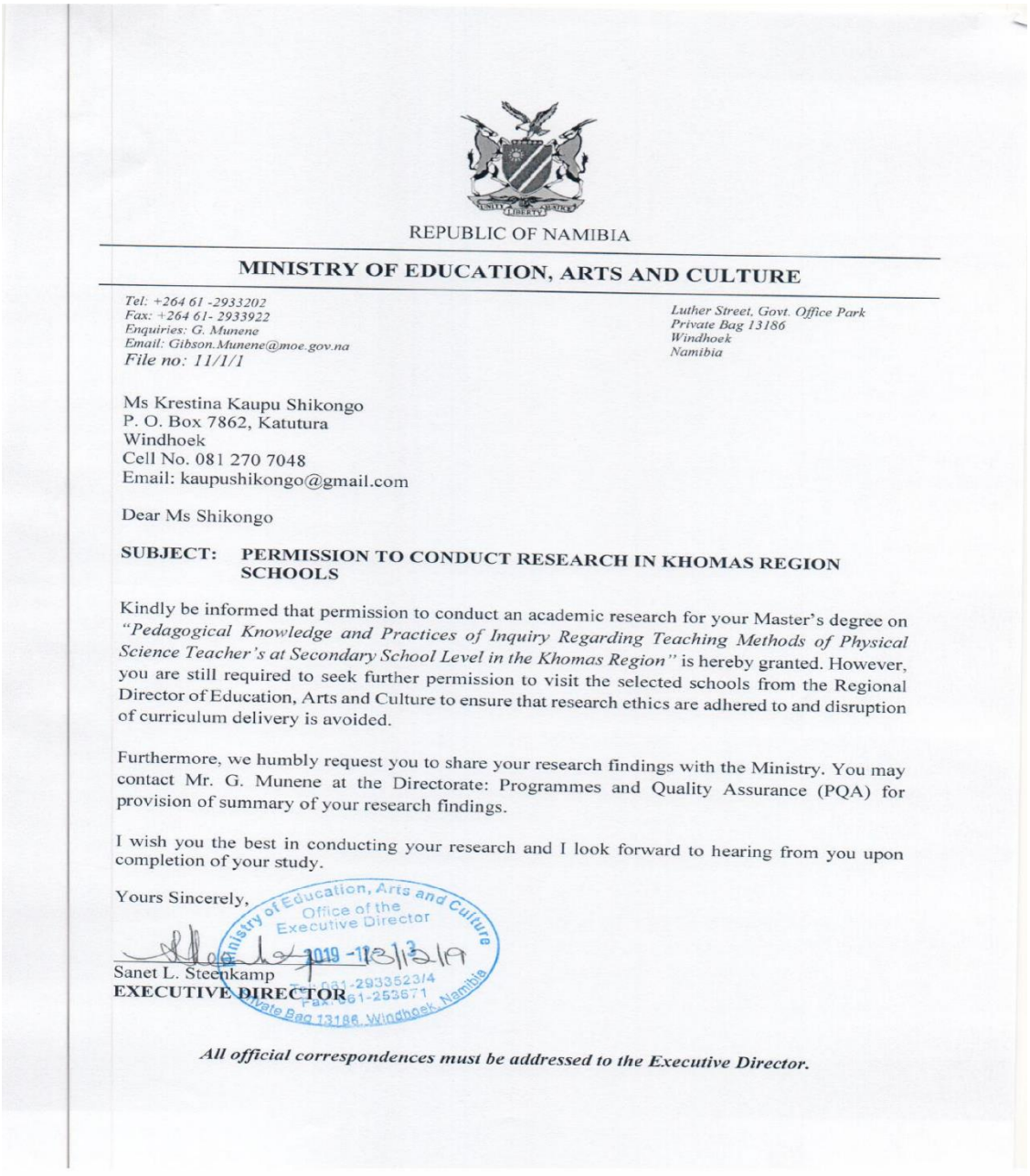
Your assistance in this regard will be highly appreciated.

Yours in Education

Krestina Kaupu Shikongo

APPENDIX C:

Permission letter from the Executive Director



REPUBLIC OF NAMIBIA

MINISTRY OF EDUCATION, ARTS AND CULTURE

Tel: +264 61 -2933202
Fax: +264 61- 2933922
Enquiries: G. Munene
Email: Gibson.Munene@moe.gov.na
File no: 11/1/1

Luther Street, Govt. Office Park
Private Bag 13186
Windhoek
Namibia

Ms Krestina Kaupu Shikongo
P. O. Box 7862, Katutura
Windhoek
Cell No. 081 270 7048
Email: kaupushikongo@gmail.com

Dear Ms Shikongo

SUBJECT: PERMISSION TO CONDUCT RESEARCH IN KHOMAS REGION SCHOOLS

Kindly be informed that permission to conduct an academic research for your Master's degree on *"Pedagogical Knowledge and Practices of Inquiry Regarding Teaching Methods of Physical Science Teacher's at Secondary School Level in the Khomas Region"* is hereby granted. However, you are still required to seek further permission to visit the selected schools from the Regional Director of Education, Arts and Culture to ensure that research ethics are adhered to and disruption of curriculum delivery is avoided.

Furthermore, we humbly request you to share your research findings with the Ministry. You may contact Mr. G. Munene at the Directorate: Programmes and Quality Assurance (PQA) for provision of summary of your research findings.

I wish you the best in conducting your research and I look forward to hearing from you upon completion of your study.

Yours Sincerely,

Ministry of Education, Arts and Culture
Office of the Executive Director
2019 -13/3/19
Tel: 061-2933523/4
Fax: 061-253671
Private Bag 13186, Windhoek, Namibia

Sanet L. Steenkamp
EXECUTIVE DIRECTOR

All official correspondences must be addressed to the Executive Director.

APPENDIX D:

Letter requesting permission to the Khomas Regional Director

P. O Box 7862

Katutura

Cell: 0812707048

email: kaupushikongo@gmail.com

20th February 2020

Khomas Regional Director

Directorate of Education

Windhoek

Dear Sir

RE: Requisition for Permission to conduct research in secondary schools in the Khomas Education region during the year 2020

I am Krestina Kaupu Shikongo, (Student No. 9967079) a registered student at the University of Namibia pursuing a Master' s in Science Education. In fulfilment of the requirements for the completion of this degree, I am required to conduct a research project. I kindly request your office to allow me to use secondary schools in the Khomas Education Region as my research sites.

The title of the research project is: **Pedagogical Knowledge and Practices of Inquiry Regarding Teaching Methods of Physical Science Teachers' At Secondary School Level in the Khomas Education Region.** The study will target a total of 8 NSSCO Physical Science teachers from four secondary school in Khomas

Namely: School A H.S, School B H. S., School C H. S. and School D H. S and two teachers will be drawn from each school. The study will be conducted through classroom observations, questionnaires and interviews of selected teachers per school. Information collected will be treated with confidentiality and will be used solely for the purpose of the research.

I hope findings for this research project will positively contribute toward improving Physical Science Teachers' pedagogical knowledge of inquiry in Khomas region. It will also help to discover problems facing Physical Science teachers in practising inquiry teaching methods, thus provide ways forward in solving such problems.

Your assistance in this regard will be highly appreciated.

Yours in Education

Krestina Kaupu Shikongo

APPENDIX E:

Permission letter from the Regional Director of Education in Khomas

REPUBLIC OF NAMIBIA

KHOMAS REGIONAL COUNCIL

DIRECTORATE OF EDUCATION, ARTS AND CULTURE

Tel: [09 264 61] 293 4356
Fax: [09 264 61] 231 367/248 251

Private Bag 13236
WINDHOEK

24 February 2020

University of Namibia
P.O. Box 7862
Windhoek
Contact: 081 2707048

For Attention: Ms Krestina K. Shikongo

REQUEST FOR PERMISSION TO CONDUCT RESEARCH INTERVIEWS WITH SECONDARY SCHOOL TEACHERS IN KHOMAS REGION

Your letter dated 20 February 2020 on the above topic is hereby acknowledged.

Permission is hereby given to you to collect data on "Pedagogical knowledge and practices of inquiry regarding Teaching Methods of Physical Science Teachers" at [redacted] High School, [redacted] Secondary School, [redacted] High School and [redacted] High School in Khomas Region under the following conditions:

- The Principal of the selected school to be visited must be contacted in advance and agreement should be reached between you and the Principal.
- The school programme should not be interrupted.
- The teachers who will take part in this exercise will do so voluntarily.
- The Directorate of Education, Arts and Culture should be provided with a copy of your thesis/ findings.

We wish you success in your research.

Yours sincerely

24/02/2020

Gerard N. Vries
Director of Education, Arts and Culture

MINISTRY OF EDUCATION
ARTS AND CULTURE
PRIVATE BAG 13236 WINDHOEK
24 -02- 2020
DIRECTOR
KHOMAS REGION

Page **1** of **1**

APPENDIX F:

Consent letter for the participant

Katutura

Cell: 0812707048

Email:

kaupushikongo@gmail.com

01st March 2020

Dear Participants

I am Krestina Kaupu Shikongo, (Student No. 9967079) a registered student at the University of Namibia pursuing a Master' s in Science Education. You are being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study staff any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the Research Ethics Committee at The University of Namibia and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and Namibian National Research Ethics Guidelines.

The aim of the research project is **to investigate Physical Science teachers' pedagogical knowledge and practices of inquiry teaching at secondary school level, Khomas education region.** This study is consists of two classroom observations per participant, closed and open ended questionnaire and a semi - structured interview. Your truthful responses will help in improving Physical Science Teachers' pedagogical knowledge regarding inquiry teaching method. Information that you will be provided will be treated with confidentiality and will be used solely for the purpose of the research.

Your assistance in this regard will be highly appreciated.

Yours in Education

_____

KRESTINA KAUPU SHIKONGO

Declaration by participant

By signing below, I ……..……. agree to take part in a research study entitled **Physical Science teachers' pedagogical knowledge and practices of inquiry teaching at secondary school level, Khomas education region..**

Signature …….. Date: ……..

APPENDIX G:

Observation checklist

CLASSROOM OBSERVATION CHECKLIST

SCHOOL CODE:…….. TEACHER CODE:……

LESSON CODE:……. NAME OF TOPIC:……

DATE: ……. TIME: …….

CLASS SIZE: …….

The researcher will observe the lesson and rate the teaching and learning activities listed in the observation checklists as per research questions. During the observation, the focus will be on whether the activity is done or not. When the activity is done a cross is placed in the 'Yes' box, if not then a cross is placed in the 'No' box. In section B the observer ill use likert scale to rate the occurrence of each behaviour as it observed. The likert scale starts from 1 to 5, the bigger the number the more the behaviour observed and the smaller the number the less the behaviour observed.

SECTION A: Steps in inquiry method

Engage		**Yes**	**No**
1.1	Learners identify problem		
1.2	Activity provided an opportunity for active learning		
1.3	Learner are asked question to assess their prior experience about the topic.		
1.4	Connections between previous and present learning experiences is made.		
Explore			
2.1	Learners are encouraged to use prior experiences to generate new ideas		
2.2	Learners explore possibilities		

2.3	Learners are allowed to design and conduct investigation through activities.		
Explain			
3.1	Learners analyse and explain the results of their exploration		
3.2	Learners explain their understating of their findings		
Elaborate			
4.1	Learners extend their understanding to other projects		
4.2	Learners make connections to other related concepts within the same content		
4.3	Learners apply their understanding to the world around them		
Evaluate			
5.1	Teacher and learners evaluating the activity/project as a whole		

Section B: Pedagogical strategies [For research question 1.]

In this question I am hoping to get information about PK inquiry skills

Key 1 = behaviour rarely observed

2 = behaviour occasionally observed

3 = behaviour often observed

4 = behaviour frequently observed

5 = behaviour consistently observed

Na = not applicable

Classroom Management						
- Teacher create conducive learning environment	1	2	3	4	5	Na
- Teacher monitor the whole classroom	1	2	3	4	5	Na
- Teacher praises learners for their contribution and involvement.	1	2	3	4	5	Na

-	Teacher provides positive feedback.	1	2	3	4	5	Na
-	More time was spend on learning activities.	1	2	3	4	5	Na
-	Teachers corrects behaviour immediately	1	2	3	4	5	Na
	Knowledge of inquiry method						
-	Teacher knows when and how to apply which teaching method	1	2	3	4	5	Na
-	Learners are encouraged to interact and communicate with each other during their investigations or during class discussions.	1	2	3	4	5	Na
-	Teacher prepares the learning environment where learners can discover new knowledge.	1	2	3	4	5	Na
-	Teacher serve as guide and provides learning activities for learners' investigations.	1	2	3	4	5	Na
-	Teacher provide rich learning activities that are related to learners' lives.	1	2	3	4	5	Na
-	Teacher make use of appropriate teaching and learning aids during the lesson.	1	2	3	4	5	Na
-	Teacher encourage learners to use correct scientific language. e.g. ''measuring cylinder'', **not** just a cylinder.	1	2	3	4	5	Na
-	Teacher encourages learners to work in groups or in pairs.	1	2	3	4	5	Na
-	Teacher presents the materials in a logic manner.	1	2	3	4	5	Na
	Implementation of lesson						
-	Teacher allows learners to handle materials (where applicable).	1	2	3	4	5	Na
-	Learners are allowed to use different methods to solve problems.	1	2	3	4	5	Na
-	Learners are asked to give more than one solution to the problem.	1	2	3	4	5	Na
-	Learners are encouraged to answer others learners' questions.	1	2	3	4	5	Na
-	Teacher emphasises main points of the lesson.	1	2	3	4	5	Na
-	Teacher corrects learners' misconceptions.	1	2	3	4	5	Na
-	Teacher gives immediate feedback to the learners after presenting their findings.	1	2	3	4	5	Na
	Evaluation of inquiry Activities						
-	Learners' assessment activities are linked to the syllabus objectives	1	2	3	4	5	Na
-	Teacher marks all learners' activities	1	2	3	4	5	Na
-	Teacher keep record of learners projects	1	2	3	4	5	Na

APPENDIX H:

Physical Science teachers' questionnaire

Introduction

My name is Krestina K. Shikongo, a student doing Master in Science Education Degree at the University of Namibia. The aim of this study is *to investigate Physical Science teachers' Pedagogical Knowledge of inquiry method at secondary school level in the Khomas Education region*. Please kindly respond to the questions and statements as completely and honestly as you can. Your cooperation and contribution towards this study will be highly appreciated. All information provided herein will entirely and strictly be kept confidential. (**Do not write your name on this questionnaire)**

Definition: Inquiry teaching method refers to the process of involving students in developing questions for investigations, designing investigation procedures, collecting and interpreting data, drawing conclusions from the data and communicating the findings (Mkimbili, Tiplic &Ødegaard, 2017).

SECTION A: Background Information (Place a cross **X** in box next to your choice).

1 Gender:	Female	☐	Male	☐
2. Age Group:	21 – 30	☐		
	31 – 40	☐		
	41 – 50	☐		
	51 – 60	☐		

3. What is your **highest** profession qualification?

HED ☐

☐09

PGDE

BETD ☐

B Ed ☐

Other (state)

……..

4. What are your Major subjects?

- Physical Science and Mathematics
- Physical Science and Biology
- Other (state) ……..

5. How long have you been teaching Physical Science?

1 year - 5 years ☐

5 years - 10 years ☐

11 years - 15 years ☐

15 years and more ☐

SECTION B: Information on teaching methods

1. For the inquiry teaching method that you use the most to teach Physical Science, briefly describe how you use this method. (For research question 1)

……

……

2. Give reasons why you use a particular teaching method more than others? (For research question 1)

……

……

……

……

4. Why do you use some teaching methods less often or not at all to teach Physical Science then others methods? (For research question 3)

……

……

SECTION C. Steps in inquiry method

Steps in inquiry method
Engage
Explore
Explain
Elaborate
Evaluate

1. Explain why you do not use some of the steps of inquiry teaching method above. (For research question 3)

……

……

D. Pedagogical knowledge

1. How often do you use each of the following pedagogical strategy? (For research question 1)

Cross (X) in appropriate box (es)

Preparation for teaching	**Always**	**Often**	**Sometimes**	**Seldom**	**Never**
Classroom management					
Knowledge of teaching methods					
Knowledge of individual					

learners					
Implementation of the lesson					
Questioning techniques					

1. Give the reasons to why you do not use some of the above pedagogical strategies. (For research question 3)

……

……

……

2. What type of activities and tasks do learners carry out when using inquiry teaching method? (For research question 1)

……

……

E: Challenges

1. What **challenges** do you experience when during inquiry teaching? (For research question 3)

……

……

……

2. Should you need training on inquiry teaching method what aspects would you like to be addressed? (For research question 3)

……

……

……

APPENDIX I:

Interview guide for Physical Science teachers

Brief Introduction

My name is Krestina K. Shikongo, a student doing Master in Science Education Degree at the University of Namibia. The aim of this study is *to investigate Physical Science teachers' Pedagogical Knowledge of inquiry method at secondary school level in the Khomas Education region*. Your participation in this interview is voluntary, confidentiality will be guaranteed throughout the study. Please be assured that any information obtained from this study will be used merely for the purpose of this study. You have the right not to answer some question and you may withdraw at any time you wish not to continue with the interview. The interview will be recorded for data analysis purposes, but you may decide not to be recorded if you are not willing to.

1. Do you use inquiry method in your teaching? (Yes) (No) (For research question 1)

If **yes:**

(i) Describe briefly how you use it.

……

……

If not, explain why you do not use this method.

……

……

2. (i) Have you ever received training on inquiry method? (Yes) (No) (For research question 1 and 3)

If yes:

(ii) When and how was it provided? (For research question 2 and 3)

(iii) Did the training met your expectations?

……

……

3. Do you think that you will need further training on inquiry method? (Yes) (No) (For research question 2)

……

……

3 (i) If **yes**, which aspects do you suggest training should focus on?

……

……

……

4. What are the challenges that you experienced when using inquiry teaching method? (For research question 3)

……

……

……

We came at the end of the interview. Thank you very much for your time and the views you have shared during this interview.