THE USE OF SCIENCE RESOURCE CENTRES AND LABORATORIES TO IMPROVE PHYSICAL SCIENCE EDUCATION IN MTHATHA, SOUTH AFRICA

By

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DATE: DECEMBER, 2014

DECLARATION

I declare that, "**The use of science resource centres and laboratories to improve Physical Science education in Mthatha, South Africa**" is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

This piece of work is the result of my untiring efforts through the professional guidance and supports of the supervisor whose name and signature is outlined below.

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DEDICATION

This work is dedicated to my late father, Mr. A.E. Danso, for making me an independent woman. I will always remember you, Papa!!!

ACKNOWLEDGEMENTS

I am most grateful to the Almighty God for the immense help in terms of everything He provided during my three year course at this University.

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ABSTRACT

The performance of learners in Physical Sciences in South Africa has been very poor for a very long time because of lack of basic understanding of scientific concepts. Given this background, there is the need to conduct an educational research to find pedagogical ways to improve performance in Physical Sciences in the secondary schools. Hence, the proposed study aims to investigate the use of science resource centres and laboratories to improve Physical Sciences education in Mthatha.

In the light of the literature review, a list of facts were acquired which were used to develop the questionnaire for the Physical Sciences learners and their teachers. Seven public and private high schools in Mthatha were selected for the study. Stratified simple random sampling was used to select respondents. The study followed a non-experimental quantitative design to collect data. The main instruments used were questionnaire and interview. The various responses were analysed and interpreted with the literature. It was found that, the use of science resource centre and laboratory activities, together with a more learner-centred approach to teaching would significantly improve learner performance in Physical Sciences.

The necessary recommendations and suggestions were made. It is hope that these recommendations would be taken up by the appropriate bodies to ensure that the needed benefits are obtained from the science resources, and laboratories. In this way, the science and technological base of the nation as a whole is strengthened for its development.

KEY WORDS: science education, science resources, science laboratories, science resource centres, achievements in Physical Science, learner performance, practical work, science equipment, inquiry learning.

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CHAPTER ONE

ORIENTATIONS TO THE STUDY

1.1 INTRODUCTION

Physical Sciences education has been a national priority in South Africa for several years (DoE, 2001a). However, the number of Grade 12 learners who pass Grade 12 Physical Sciences, remains very low (DoE, 2004). Since the introduction of the National Curriculum Statements (2005) in schools, the pass rate in Physical Sciences has not been encouraging at the national, provincial and the district levels (DoE, 2010).

In the Eastern Cape, the provincial department established a provincial science academy based in Mthatha in the year 2009 in direct response to this imperative of low learner performance in Physical Sciences. There is an on-going support of Physical Sciences in Dinaledi schools and the provision of science kits in GET and FET schools to enhance the practical study of the subject. Key resources have been identified, procured, and distributed to either schools or district science resource centres (Mandla, 2011). The indication is that teachers and learners use these available resources regularly to improve the quality of teaching and learning of Physical Sciences, hence, improving performance in this subject.

In this regard, the science laboratory which is considered as a unique learning environment, is a setting in which students can work in small groups to investigate scientific phenomena (Nilgun & Feyzioglu, 2012). Hence, the science resource centres provide a wide range of materials for pupils to use for their coursework in Physical Sciences. These include CD-ROMS, audio tapes, computers, reagents, models, apparatus, equipments, data sheets, projectors, and etcetera. The science resource centre is therefore pivotal in our attempt to vary the learning environment in which students develop their understanding of scientific concepts, science procedural skills, and perceptions of science. Hence, Lazarowitz and Tamir (1994) suggest that the activities carried out in the science resource centres have the potential to enhance constructive social relationships in learners as well as positive attitudes and cognitive growth in students.

Furthermore, the science laboratory has been given a very distinctive role in Physical Sciences education, and researchers are of the view that, there are tremendous benefits in learning from using laboratory activities (Hofstein & Mamlok - Naama, 2007). Researchers (Lunetta & Tamir, 1979) have expressed their views that what makes the science laboratory unique lies principally in providing students with opportunities for scientific investigation and inquiry.

Using science resources in teaching, learners attending laboratory sessions, and manipulating science materials are important aspect of learning Physical Sciences. This is because practical work in a way brings to life what is already explained in learners' textbooks, specifically, Hodson (1992) has characterised the purpose of science education as learning science by doing, that is, to be able to take part in hands-on activities that lead to the acquisition of scientific knowledge. However, Justi and Gilbert (2002) proposed the use of models and modelling activities in science teaching which help to develop scientific knowledge in learners.

This study therefore investigated the use of science resource centres and science laboratories activities to improve Physical Sciences teaching and learning and explored further into the causes of poor performance of learners in the subject.

1.2 BACKGROUND OF THE STUDY

The background of the study took into account what exactly prompted the researcher to undertake the study and for how long this prompting has been going on. A critical look at matriculation results in Physical Sciences and the performance of learners in this subject area, throws light the gloomy nature of the situation (Mji & Makgato, 2006). This situation is still continuing even ever since the introduction of the New Curriculum Statement and it was this time when all Grade

12 learners countrywide wrote a common national examination in November 2008 (DoE, 2009).

Following the implementation of the New Outcome Based Curriculum in 2005, teachers are challenged in teaching science in large classes in the continuing reform of South African's educational system. Most science teachers are operating in large classrooms and poorly resourced science laboratories (Muzah, 2011).

In view of this, Gilbert and Newton (2005) have provided an indicator for change, and this change is intended to improve the quality of Physical Sciences education in line with the principles of Outcome-Based Education and training. This led to the introduction of the Curriculum Assessment and Policy Statement (CAPS) , which was implemented in January, 2012 at all levels of the educational ladder (DoE(Basic), 2011).

However, despite attempts at curriculum reform and further attempts to make it more teacher-friendly, realities in the classroom have been slow to change in many schools. Research has shown that, *majority of teachers continued to use traditional, teacher-centred methods of monologue and rote learning, and classroom activities are being dominated by reading, writing, and corrections* (Nelson Mandela Foundation, 2005:5, as cited by Mncube & Nomanesi, 2013)

According to Hersh (1983), the entire educational system needs upgrading and there is the need to improve and provide resources for the effective teaching and learning of Physical Sciences. Sanders (1998), among others, argued for a pedagogy-based on the constructivist theory, which emphasises the importance of the learners' construction of knowledge through laboratory procedure and activities.

On the other hand, Ikraam believed that human senses play an important role in generating scientific knowledge and observation is the starting point of a scientific inquiry. He considered Physical Sciences as a practical subject and believed that; "*in the Physical Science classroom, in order to understand Physical Science the students must be given the opportunity for seeing and doing. He was of the view that providing the science learners with abstract explanations is just like building castles in the air"* (Ikraam as cited by Gough & Siemon, 2009).

Furthermore, Woolnough and Allsop (1985) supported this argument. They were of the view that the establishment of science resource centres were to enable learners master laboratory proceedings, in that mastering of laboratory procedures is fundamental to doing science and to the understanding of ways in which scientific knowledge is developed. In addition, Meyer and Carlisle (1996) have documented the actions of young students in doing experimental work.

Hence, concurred with Müller, Solomon and Driver (1997) that, prior knowledge of the social organisation of science laboratory activities, science concepts, skills and procedures play a role in the way that learners interact with new experiences (Müller, Solomon & Driver, 1997 as cited by Ogunde & Bohlman 1998). Therefore, the use of science resources cannot be overemphasised because it enhances understanding. The poor performance of learners in Physical Sciences is due often to the failure of teachers to use science resources to help learners learn and understand scientific concepts.

Regardless of the kind of Science resources, all have some function in students' learning.

According to Mji and Makgato (2006), learners supplement what is in the textbook to enhance their understanding when they see science teachers demonstrating or conducting experiments themselves in the laboratory. An advantage is that it helps improve learners' higher order learning skills by facilitating the learning process (Mji & Makgato, 2006). For example, a worksheet given to the learners may provide them with important opportunities to practice a new skill gained in the class.

1.3. THE PURPOSE OF THE STUDY

Science resource centres and laboratories were established to improve learner understanding of scientific concepts, improve performance in Physical Sciences and for the technological development of the nation.

The purpose of this study was to find out the extent to which the use of science resources and laboratory activities in science teaching and learning can improve learner performance in Physical Sciences. This move may assist the science educators in Mthatha and perhaps other parts of South Africa to modify their methods of teaching scientific concepts, to improve learner performance in Physical Sciences.

1.4 THE RESEARCH PROBLEM

As already noted in the introduction, the majority of learners in the senior secondary schools in South Africa perform very poorly in Physical Sciences because of lack of basic understanding of scientific concepts in Physical Sciences. Several interventions such as the establishment of science resource centres and laboratories, periodic review of the Physical Sciences curriculum, coupled with a number of other interventions and learner support programmes to improve the performance of learners in the subject, have failed to elevate learners' performance in the subject (DOE, 2010).

The question is why and how science learners fail Physical Science? Most learners do not develop interest in the study of Physical Sciences, as students see the subject to be very difficult and too abstract. This perception has denied many learners the expected benefits and privileges of science education. The fact still remains that most high schools in South Africa do not have science resource centres and laboratories. These schools perform poorly in Physical Sciences, as most of the topics supposed to be taught practically are being taught theoretically without the laboratories for practical learning.

Ironically, while the role of science education in promoting South African development is much acknowledged, the problem of science education and academic achievement in South Africa is least understood. The dissertation works with some key questions such as: What roles do we see for science resource centres and laboratories in South African educational system?

Given this background, there is the need to conduct an educational research to find pedagogical ways to improve performance in Physical Sciences in the secondary schools. Hence, the proposed study aims to investigate the use of science resource centres and laboratories to improve Physical Sciences education in Mthatha.

1.4.1 The research question:

The main research question of the study was:

- How do laboratories and science resource centres improve learner performance in Physical Sciences education in Mthatha schools?

Among the sub-questions:

- What strategies are employed in teaching Physical Sciences in laboratories and science resource centres to enhance scientific literacy in Mthatha schools?
- What accounts for the falling performance levels of learners in Physical Sciences in Mthatha Schools?
- What is the difference in performance in Physical Sciences between schools with well-equipped science resource centres and laboratories and schools without science resource centres and laboratories?
- What are the educational challenges of using the science resource centres and the laboratories?

1.5 RESEARCH AIM AND OBJECTIVES

The aim of this study was to find out the extent to which the use of science resources and laboratory activities in science teaching and learning can improve learner performance in Physical Sciences. Physical Sciences is a subject where ideas are linked with practical investigation. In addition, Physical Sciences requires demonstrable evidence of the validity of any theory. Part of teaching science is to bring about scientific thinking in learners; a mind that requires learners to test out through experimentation.

In addition, to inspired pupils to embrace the opportunities which Physical Sciences will present to them and prepare them for science subjects at top universities, through inquiry learning in the laboratory. Through inquiry learning, learners are giving the chance to manipulate scientific resources and with this, the new generation of young people will see Physical Sciences as an exciting and attractive subject to study.

1.6 RESEARCH HYPOTHESIS

$H_{o\ =}$ The use of science resources in teaching Physical Science has no significant impact on the performance of learners in Grade 11 and 12.

1.7 THE SIGNIFICANCE OF THE STUDY

The significance of the study indicates why the study is important and the reasons for the choice of a particular problem for the study (McMillan & Schumacher, 2001:99). Most schools in Mthatha face many challenges when it comes to teaching learning materials. Therefore, the findings of this study would help to improve upon programme planning at the Department of Education with reference to the utilisation of available science resource centres and laboratories.

The study would also help the Department of Basic Education to know the problems experienced by the schools with regards to science resource usage, since they require periodic information on the use of educational facilities in schools.

Finally, the Department of Basic Education would find the suggestions and recommendations useful in running in-service programmes for teachers as well as co-coordinators and laboratory technicians for the resource centres.

1.8 RESEARCH DESIGN AND METHODOLOGY

This study followed a non-experimental quantitative, survey research to collect data. In a survey, the researcher selects a sample of respondents from a larger population and administers a questionnaire or conducts interviews to collect information on variables of interest (McMillan & Schumacher, 2010: 233).

The study explored the use of science resource centres and laboratories to improve Physical Sciences education, using two research design instruments; questionnaire and semi-structured interview. Two private high schools and five public high schools with or without science laboratories were randomly selected for the study. The seven schools selected form 30% of the schools in Mthatha. Stratified simple random sampling was used to select the subjects for the study. In all, ninety three (93) science learners, seven science teachers and seven school principals, were selected, given a total sampled size of one hundred and seven (107).

Questionnaires were pilot tested in two schools before the main study to increase reliability and validity of the questions. Questionnaires for the main study were self-administered and collected immediately on completion. Interviews were conducted thereafter.

Permission to conduct the research was requested from the Eastern Cape Department of Education (Appendix A), which was granted (Appendix B). All participating schools and all respondents were given letters of request which guaranteed confidentiality of information from respondents.

1.9 DATA ANALYSIS AND INTERPRETATION

Gay *et al*. (2006:5) described data analysis as a systematic organisation and synthesis of data that involves application of one or more statistical techniques. Data were analysed based on the responses from respondents. One hundred (100) questionnaires from science learners and science teachers were completed and collected, together with the responses from the interviews. The researcher examined each of the response patterns and data were analysed based on the responses given by respondents (Gay *et al*. 2006:172).

Data were analysed and interpreted using descriptive analysis which were presented in the form of graphs, percentages, and tables. Descriptive statistics were used to summarise, organise and reduce large numbers of observations or make sense of a particular data (Johnson & Christensen, 2008:177).

1.10 LIMITATION OF THE STUDY

This study had the following limitations:

- The use of science resource centres and laboratories to improve performance of learners in Physical Sciences has been selected for the study. Some factors that cause learners to fail Physical Science were not considered during the study.
- The population samples were Grade 11 and Grade 12 Physical Sciences learners, their teachers and principals from randomly selected public and private high schools in Mthatha. Thus, the implications of the study would be valid only for the schools in Mthatha compared to the many schools in the Eastern Cape Province and the whole of South Africa.

- Learners in Grade 11 and Grade 12 Physical Science class had been the major focus of the study. Learners in the other grades such as Grade 10 were not considered for the study.
- One major problem facing educational research in South Africa is that of finance to undertake the research. This has been a major factor in this research.
- There was also little, if any at all, information on the research topic since it is a new area.
- The study did not cover all the science resource centres and laboratories in South African schools. It covered only randomly selected high schools with and without science laboratories in Mthatha.
- Principals, science teachers, and science learners were the respondents for the study. Most science laboratories never had laboratory technicians.

1.11 OPERATIONAL DEFINITION OF TERMS

The definitions and meanings of terms used in this study are as outlined below:

- "Physical Sciences education": is a way of learning to know the physical and chemical aspects of the norms and culture of man and his environment in its fundamental laws of nature, therefore education as a process of learning aimed at equipping people with knowledge and skills (DBE, 2011)
- "Science process skills": skills refer to the correct application of knowledge to the practical task, therefore science process skills refer to the process whereby science knowledge is applied with congruent skills to a practical task.
- "Concepts": is an idea underlying a class of things. Any idea or subject under discussion can constitute a concept (Oxford Advanced Dictionary, 2005).
- "The learning and teaching support" and available material (TLSM): refers to stationary, textbooks, study guides, aids, equipments, apparatus, resources available to the learner and the teacher in the classroom (DoE, 2003).

- “Equipments”: the set of articles or physical resources serving to equip a person or the implements used in an activity.
- “Laboratory”: a place equipped for experimental study in science or for testing and analysis; a place providing opportunity for experimentation, observation, or practice in a field of study (Oxford Advanced Dictionary, 2005).
- “Department of Basic Education”: an embodiment of education authorities that see the proper implementation and evaluation of all educational policies (DoE (Basic), 2003).
- “Curriculum 2005”: is an official name given to the curriculum, which was implemented after the apartheid government. It focuses on lifelong learning and was developed within the Outcome Based Education framework (Aldous 2004:65, Van der Horst & MacDonald 1997:243).
- “Further education and training(FET)”: is the phase of the educational structure, starting from Grade 10 to Grade 12, where learners have the option to choose a programme of study with minimum subjects of seven (7) and maximum of nine(9).
- “National Curriculum Statement (NCS)”: these are documents detailing the new curriculum in terms of learning areas. The document includes the assessment guidelines, read in conjunction with the relevant subject statements, and learning programme guidelines (DoE, 2008).
- “Practical Work”: Practical work in the context of this study means the teaching and learning activities in Physical Sciences that involve learners at some point handling or simply observing the teacher handling or manipulating tools or materials (Ogilvie, 2007:105-107).
- “Inquiry”: The word inquiry refers to the quest for knowledge, data, or truth. Students take part in inquiry investigations to help them acquire more meaningful conceptual science knowledge, (Lunetta *et al*., 2007: 396).
- “Investigation”: It refers to the process of inquiring for ascertaining facts through careful examinations.

- "Attitudes": This refers to the feelings that a person has about an object, based on their belief about the object. (National Academy of Science, 2008:2).
- "Outcome Based Education (OBE)": forms the foundation for the curriculum in South Africa in which outcomes are specified to enable learners to reach their full potentials (DoE, 2003:2).

1.12 ACRONYMS

NCS	National Curriculum Statement
CAPS	Curriculum and Assessment Policy Statement
CD	ROM Compact Disc - Read-only Memory
DoE	Department of Education
DBE	Department of Basic Education
DVD	Digital Versatile Disc
FET	Further Education and Training
GET	General Education and Training
ICT	Information and Communication Technology
NEIMS	National Education Infrastructure Management System
NRC	National Research Council

1.13 OUTLINE OF CHAPTERS

The chapters of the study have been outlined as follows:

Chapter One of this study gives orientation to the following; giving orientation to the study, the background of the study, statement of the problem, the aim of the study, significance of the study, and limitations, with the discussion of each one.

Chapter Two introduces the theoretical framework and the literature review. Brief commentaries with subheadings contributing towards the identification of the gap lapse which this study was to fill , were discussed. The chapter also demonstrates how the research question fits into a larger field of study globally and in South Africa. As a result, books, articles, magazines, websites, newspapers were consulted to verify and explain the research question.

Chapter Three deals with research methodology, design, and application for the investigation of the research, sampling, data collection techniques, reliability, and validity of the instrument and ethical considerations, with the discussion of each one.

Chapter Four focuses on data collection. Data were analysed using statistical methodology in the form of tables and figures.

Chapter Five presents the interpretation of the evidence revealed by the analysed data leading to the provision of the summary, conclusion and recommendations for future studies.

References: this section provided a list of all the authors that have been used in the research project as required by Harvard referencing style.

List of Appendices: this section provided the sample of the informed consent forms issued to the potential participants. It also provided permission letters granted from the gatekeepers such as the Department of Education and the principals of the selected schools where the research was conducted.

1.14: SUMMARY

Physical Sciences education has been a national priority in South Africa for several years. This is because the number of Grade 12 learners who pass Physical Sciences remains very low. This has discouraged most learners from taking Physical Sciences in the high schools. Given this background, there is the need to conduct educational research in which the use of science resource centres and laboratories to improve Physical Sciences education were emphasised in science teaching. Hence in this chapter, the orientation of the study was put into perspective. The introduction, background of the study, aims, the research problem, and significance of the study were presented. In addition, as well as the limitation of the study was discussed. Definition of terms and chapter outlined were also discussed in the study.

. CHAPTER TWO

THE LITERATURE REVIEW

2.1 INTRODUCTION

A literature review is a very thoughtful and well informed discussion of relevant literature that builds a logical framework for the research that sets it within the context of relevant studies (De Vos, 2005:123). Hence, the process of reviewing literature involves finding the sources, reading and paraphrasing the sources, understanding and forming conclusions about published research and presenting it in a logical and sequential manner (Brink, 2006:67),but also to show gaps and weaknesses and to draw the point of departure for the study.

The literature review in this study aims at finding out what has been researched on the use of science resources centres and science laboratories to improve the performance of learners studying Physical Sciences in senior secondary schools in South Africa. This provides justification as to how this research is different from what has been published. The emphasis here is on the teaching and learning, aiming at identifying, understanding factors, and related issues that affect teaching and learning of science using resources in the science resource centres and the laboratories, which eventually improve learner performance in Physical Sciences in matric examinations across South African schools.

Finally, the literature further provides a purpose for doing the proposed study and is used to form a theoretical framework for understanding science laboratories and science resources centres and the role and implications of what the South African Physical Sciences education and that will inform the design and methodology of the proposed study.

2.2 THE TEACHING AND LEARNING OF PHYSICAL SCIENCE

Human learning is a very complex process and appropriate devices must be paired with appropriate teaching and learning theories and methodologies. An example of an integrated social learning approach that focuses on more accessible technology is "knowledge building" (Scardamalia 2002; Scardamalia & Bereiter, 2003).

Scardamalia and Bereiter argue that creative work with ideas is essential to knowledge work in a knowledge society, and that the most central and important task of education is to motivate the students into a knowledge-creating culture where sustained idea improvement is the norm. Knowledge building extends beyond learning, resulting in the creation, modification, and advancement of ideas that live "in the world." Therefore, engaging students in the laboratory activities is a knowledge creating process and should be paired with appropriate learning theories and methodologies.

2.2.1 Teaching

Teaching is a complex cognitive skill that requires problem solving in a changing environment (Dijkstra, Van Hout Worlter & Van der Sijde, 1990). Teaching therefore, involves two consecutive process: planning and execution (Anderson, Greens, Kilne & Neves, 1991). Planning influences what students will learn, because planning completely transfers the available time and curriculum materials into activities for the students to practice on (Morine-Dershimer, 2006, as cited by Woolfork 2010). Execution, on the other hand, involves putting plans into action.

2.2.2 Learning:

Learning occurs when experiences cause a relatively permanent change in an individual's knowledge or behaviour. This change may be deliberate or unintentional, conscious or unconscious, correct or incorrect (Schunk, 2008 as cited by Woolfolk, 2010). Therefore, this change in behaviour must be brought about by experience – by the interaction of a person with the environment. Hence, these changes resulting from learning must occur in the individual's knowledge or behaviour (Woolfolk, 2010).

2.3 TEACHING AND LEARNING IN THE SCIENCE LABORATORY AND THE SCIENCE RESOURCE CENTRE

2.3.1 The school science laboratory

The laboratory has been given a pivotal and a very unique role in science education, and science teachers have recommended that rich benefits in learning accrue from using laboratory activities (Hofstein & Lunetta, 2003). Therefore, the science laboratory is a unique learning environment, a school setting where students interact with materials to observe and understand the natural world (Hofstein & Mamlok, 2007).

In addition, the laboratory is a facility that provides controlled conditions in which scientific or technological research, experiments, and measurement may be performed (http://www.sciencefirst.com/physics.html). Thus, it has the potential to provide science teachers with opportunities to vary their instructional approaches so as to avoid a monotonous classroom-learning environment. Lazarowitz and Tamir (1994 as cited by Hofstein *et al*. 2007:61) supported this argument and described the laboratory as the only place in the school where different kinds of inquiry skills can be developed. In view of this, the science laboratories may differ from school to school, but despite the great differences among laboratories, some features are common. The use of workbenches or countertops of which learners and student may choose to either sit or stand is a common way to ensure comfortable working conditions. Cabinets for the storage of laboratory equipments are also found in laboratories.

Hence, laboratory equipment refers to the various tools and equipments used by teachers and learners working in a laboratory. These include tools such as Bunsen burners, and microscopes as well as specialty equipments such as operant conditioning chambers, spectrophotometers and calorimeters. Another important type of laboratory equipment is laboratory glassware such as the beaker or reagent bottle, or even a thermometer(http://www.sciencefirst.com.html). Laboratory equipment is generally used to either perform an experiment or to take measurements and gather data. Bigger or more sophisticated equipment is called a scientific instrument.

Various activities are carried out in the laboratory. Therefore, laboratory activities are learning experiences in which students interact with materials to observe and understand the natural world. In the science laboratory, scientific activities are performed. Therefore, students who engaged in science laboratory activities (Hofstein & Lunetta, 1982; 2004; Tobin 1990; Hodson, 1993; Lazarowitz & Tamir, 1994; Lunetta *et al*., 2007) make observations, generalisations based on their observations and finally, make scientific conclusions. Hofstein and Mamlok (2007) alluded that some laboratory activities have been designed to engage individual students, while others have sought to engage students in small groups and in large-group demonstration settings. Tobin supports this argument. He wrote that; "*Laboratory activities appeal as a way to learn with understanding and, at the same time, engage in a process of constructing knowledge by doing science*" (Tobin, 1990, as cited by Hofstein & Mamlok, 2007).

According to the Department of Basic Education (DoE, 2011:8), science education aims *"to allow students to investigate physical and chemical phenomena through scientific inquiry and the application of scientific models, theories and laws in order to explain and predict events"*. Therefore, scientific and technological knowledge is important to address the challenges facing society. This led to the establishment of science laboratories to address this imperative in schools.

Over the years, many scholars have argued that science cannot be meaningful to students without interesting experiences in the science laboratory (Hofstein & Mamlok, 2007). Laboratories have the potential to develop students' interest, abilities, and skills. Such skills as: posing scientific questions (Krajcik *et al*., 2001; Hofstein *et al*., 2005), forming hypotheses, designing and conducting scientific investigations, recording observations and communicating and defending scientific arguments. These skills are potential to be an important medium for introducing students to central conceptual and procedural knowledge in science."

Furthermore, science laboratory equipment allows students to scrutinise the information gathered from the books, as well as from the material world, for developing pragmatic knowledge and rationale. Students use the various tools to conduct experiments, by using different techniques to improve their overall science literacy (www.sciencefirst.com/physics). Many of the world famous scientists and researchers we hear of today, developed their lifelong interest in science in their school science laboratory only when they carried out their first science experiment in their school science laboratory. Schools must therefore, invest in up-to-date and highly advanced sophisticated science laboratory equipments so as to produce highly skilled and competent students, who will take over the scientific and technological labour force and to assure the country of a great future in the field of advancement in medicine and technological developments (www.sciencefirst.com/physics).

Physical Sciences is different from any other subject that a learner offers in school. Science involves observing, handling, understanding, and manipulating real objects and materials in the laboratory. Research has shown that educational institutes that combine theoretical classroom teaching with science laboratory experiences are able to derive the best results for their students (Niewenhuis & Maree, 2008). Hence, school science laboratory plays an important role in the development of students' interest in science and for the advancement of technologies made in the world.

2.3.2 Teaching Physical Sciences in the science laboratory

Laboratory teaching is a complex phenomenon because there are interactions between learners and teachers, learners and activities, learners and equipments, and learners and learners. All these interactions cannot guarantee for observations only, as claimed by Garatt (2002: 58), but will help to develop a variety of science procedural and science process skills. Physical Science teaching therefore requires a different approach of teaching and learning and schools must provide opportunities for such a process. Teaching in the laboratory requires the active engagement, hands-on, minds-on activities with laboratory materials and techniques.

In view of this, NIED (2005:1) suggested that the teaching of theoretical lessons in the classroom must proceed with practical work in the laboratory on the topics covered in the theoretical lessons. Through this process, learner's knowledge and understanding of a particular concept in science are enhanced and consolidated by the practical experiences they go through after each theoretical lesson.

In addition, Lunetta *et al*. (2007:332) defined practical work as: learning experiences in which learners interact with materials and resources to observe and understand the natural world. The quality of teaching and practical activities in the laboratory varies considerably, but there is strong evidence, from literature that "*when well-planned and effectively implemented, science laboratory teaching and experiences situate learners' learning in varying levels of inquiry. Therefore, requiring students to be mentally and physically engaged in ways that are not possible in other science education experiences"* (Lunetta *et al*., 2007: 405).

Millar similarly argues that practical work is a very prominent feature of science and hence, it leads to better understanding of scientific concepts and learners tend to remember the things they have done in the laboratory than the things they have merely been told in the classroom (Millar, 2010: 108). Millar further argued that practical work in a way stimulate learners interest in science and encourage them to pursue the subject further at the high levels of the educational ladder.

Moreover, Domin (1999:545) identified four techniques that can be applied to teach learners in the laboratory, depending on the specific aims and learning outcomes of the laboratory lesson. These are the expository, inquiry, discovery, and problem-based methods. In addition, Domin (1999) indicated that, cognitive impact is being enhanced if the following factors that promote learning are considered:

- Allow the learners to think about the purpose of their investigation and the sequence of activities they need to pursue to achieve their aims.
- Assessment and prompt feedback should be given in order for learners to take practical work more seriously.
- Teachers should probe outlined activities and be informed on what is best practice.

Domin (1999: 545) further stressed on the effectiveness of giving learners authority over laboratory activities (learner- centred) by allowing them to choose topics from the science content to investigate. This will assist learners to link up the concept with their prior knowledge to enhance inquiry learning. Hence, learners acquire higher order thinking skills of formulating the hypothesis, predicting the results, generating a methodology, performing the investigation, recording their observations, and drawing up conclusions.

2.3.3 The science resource centre

The science resource centre is a unique educational resource centre that houses science resources (www.serc.sjsu.edu/). The science resource centre provides a wide range of materials for learners to use for their coursework in Physical Sciences. These include: CDs, CD-ROMS, audio tapes, computers, software, reagents, models, apparatus, multimedia, hypermedia, equipments, data sheets, projectors, and etcetera. The CD-ROM features highly interactive multimedia teaching tools that can transform the explanation of difficult concepts such as the photoelectric effect and electromagnetic induction and effectively engage learners to think constructively (http://platolearning.co.uk as cited by Kotoka, J.K. 2012).

Therefore, the science resource centre boasts of an interactive science, career guidance, and high tech ICT resource facilities, which provides a variety of professional development opportunities for both public and private school teachers and learners. The centres have the capability to link up with other schools in other parts of South Africa using broadband satellite and are equipped with interactive white board technology, enabling learners in other schools to participate actively in lessons without having to physically leave their classrooms (www.digitalclassroom.co.za). The centre also provides a fun and interactive way for students to enjoy Physical Sciences as well as learn problem-solving skills.

Hence, the main goals of establishing science resource centres (adapted from www.saastec.co.za) include:

- To establish a centre of excellence that provides facilities for both learners and teachers to take science teaching and learning to an elevated level of understanding;
- To improve teacher knowledge content of scientific concepts that pertains to the six knowledge areas of Physical Sciences in FET band;
- To provide teachers with experiences of pedagogical approaches in teaching science to increase student achievement in science;
- To engage teachers in dialogue with scientists and engineers who are conducting research at the centres;

- To assist teachers to familiarise themselves with the resources available at the centres that may be used to support the teaching and learning of science;
- To expose learners to the field of science and to encourage them to choose Science as subject at higher educational levels; and
- To encourage workshops and courses aimed at upgrading science teachers' practical teaching capabilities and bridging the content knowledge gap among teachers.

A number of these science resource centres have been established across South Africa for the reasons of improving teacher competence and learner achievement in science. Among them are;

- MTN ScienCentre: The MTN ScienCentre is an interactive science centre where you can have fun, while learning about scientific discoveries and technological innovations (mtnsciencentre.org.za).
- Southern African Association of Science and Technology Centre: the centre focuses on promoting the understanding and uses of science and technology through "hands-on" exhibits, displays, and programmes (www.saastec.co.za).
- Vuwani Science Resource Centre. This is located in the rural community of Venda. The main aim was to bring Science, Mathematics and Technology closer to the rural people. The centre has four laboratories in which learners from the schools in the region use these facilities to acquire hands-on experiences.

  (www.univen.ac.za/index.php?).

In the Eastern Cape Province, the Vodacom Resource Centre was established in Lady Frere to train teachers in the use of technology. The centre has access to curriculum content and teaching aids through cloud computing which is an internet-based warehouse of educational content (www.digitalclassroom.co.za).

In addition, the provincial science academy based in Mthatha was established in 2009 in direct response to improving Physical Sciences education (Mandla, 2011).

Hence, in a study on the main forms of ICT relevant to school science activities in the science resource centre, Hennessy (2003) suggested that, tools for data capturing, processing and interpretation, multimedia educational software and publishing are relevant for science teaching and learning. Therefore, the teaching and learning of science requires additional formats above what is in a text.

Furthermore, in more affluent societies, science teaching is supported by use of resources, sophisticated equipments, demonstrations and experimentations that occur in the science resource centres. Whilst in a traditionally disadvantaged communities, such facilities seldom exist, but the use of e-learning applications can help to compensate for this lack of resources. Hypermedia is an example of e-learning applications, which is a technique by which graphics, animations, audio and video are linked together electronically in a non-sequential way (Kasonga, 2005).

Research into the use of hypermedia-based learning systems in science (Siorenta & Jimoyiannis, 2008) at the resource centres has led to the understanding of their roles in science teaching and learning. Hypermedia implementations are not limited to the Web, and as such, they can be used as CD-based multimedia.

In addition, Ball (2003) indicated that, e-learning has the following advantages: as a tool, a source of reference, a means of communication and a means of exploration. The use of e-learning in science teaching offers learners a bridge between concrete and abstract thinking, allowing them to observe and manipulate scientific phenomena and create multiple representations of science concepts in their minds (La Velle, McFarlane & Brawn, 2003; Osborne & Hennessy, 2003).

2.3.4 The difference between science resource centre and the science laboratory

The science laboratory, as already mentioned, is a place equipped for experimental study in science or for testing and analysing scientific phenomena. It is a place which provides opportunity for experimentation, observation, or practice in a field of study and therefore, the laboratory is usually established in schools.

The science resource centre is a unique educational resource centre that houses science resources (www.serc.sjsu.edu/). The science resource centre provides a wide range of materials for learners to use for their coursework in science.

Hence, for the purpose of this study, the main difference between a science resource centre and a science laboratory is that the science resource centre has more high-tech and advanced ICT facilities than the science laboratory (Wellington, 2000). According to Wellington, the use of technology in the science resource centre incorporates the use of software programs such as word - processing, spread sheets, and databases. It further includes the use of simulations, data logging, and multimedia to support conventional teaching in science.

According to Alessi and Trollip (2001:10), there are various interactive multimedia (IMM) facilities that are used to facilitate teaching and learning in the science resource centres. These include tutorials, hypermedia, drills, simulations, games, tools, computer-based testing, and web-based learning. The IMM facilities that are of significant relevance in science education are tutorials, simulations and drills and the use of software packages, such as databases and spread sheets.

These high-tech technologies seldom exist in the science laboratory in schools. Basic equipments such as reagents, Bunsen burner, beakers, conical flasks, apparatus, pipettes, a microscope, a computer, and etcetera are commonly found in the science laboratory.

2.4. THEORIES OF TEACHING AND LEARNING UNDERPINNING SCIENCE TEACHING AND LEARNING IN THE LABORATORY AND THE RESOURCE CENTRE

The use of science resource centres and science laboratories in teaching and learning of Physical Sciences relate effectively with most learning theories.

2.4.1 Why Learning Theories in Teaching and Learning of Science

Literature illustrates the growing realization that learning theories have great value in the organisation of knowledge, the direction of research for new knowledge, the solution of problems, and understanding how children learn and therefore facilitate teaching and learning processes in the classroom, and in particular, in the laboratory (Berk 2006:264, Donald et al 2006:89, De Witt 2009:52, Morrison 2009:170, Mwamwenda 2004:170).

Therefore this section proceeded by comparing and contrasting some of the learning theories underpinning the use of resources in science teaching and also provided suggestions on how they can be applied in the use of resources in teaching and learning of Physical Science the high schools.

2.4.2 The behaviourist theory

Behavioural views of learning generally assumed that the outcome of learning is a change in behaviour of an individual. In the broader sense, learning occurs when experience causes a relatively permanent change in the knowledge or behaviour of an individual (Schunk, 2008). It is acknowledged, in behavioural view that, learning reveals itself only through behaviours that can be observed (Daron *et al*. 2009:150; Sternberg 2003:444). In addition, researchers emphasised learning through observation of others (Bandura, 1977); Hill, 2002; Zimmerman & Schunk, 2003). Through observational learning, people learn not only how to perform behaviour but also what will happen to them in specific situations if they do perform that behaviour. Observation therefore, can be a very efficient learning process.

Hence, students learn better, when they observe the teacher uses science resources to demonstrate a scientific concept in the laboratory.

2.4.3 The social constructivist theory

Social constructivists believe that, for learners to gain deep understanding of what they learn, they must actively come to know the concepts for themselves. Learners must be allowed to explore phenomena or ideas, formulate their own hypotheses, and to share their hypotheses with others and where necessary, to revise their thinking process using information from their present knowledge (Smith, 1997). Hence, a social constructivist framework has special potential for guiding teaching in the science laboratory and the science resource centres.

This argument put forward by Smith was supported by Tobin (1990), who noted that, science laboratory activities allow students to learn with understanding and further, engage them in a process of constructing knowledge by doing science. In addition, constructivism teaching strategies are recognised to have a great effect in self-regulated learning (Powell & Kalian, 2009). Self-regulated learning fosters learners' curiosity to create new meaning from what they have taught (Deksissa *et al*., 2014).

Moreover, constructivism suggests applying teaching methods which force the learner to be an active player. Such methods should encourage the learner to become cognitively engaged in developing a personal understanding of the topic being taught. The more elaborated interpretation of constructivism not only seeks to make learners active thinkers, but also to promote interaction and collaboration between them and other learners (Kapanadze & Eilks, 2013).

Constructivism theory also suggests learning through interpersonal communication and social interaction as being essential for effective learning (Eilks *et al*., 2013). This important assertion may be valid, but current research also suggests that helping students to achieve desired learning outcomes is not just by doing, but is a very complex process. According to Gunstone (1991), using the science resources to make students construct their knowledge may seem reasonable but developing scientific ideas from practical experiences is a very complex process, which is not just about construction of knowledge of students.

Gunstone and Champagne (1990) further suggested that meaningful learning in the science laboratory would occur if students were given enough time and opportunity to practice while they interact with the available resources, making inquiries and constructing their knowledge and reflecting on their ideas. Gunstone wrote that *"students generally did not have enough time or opportunity to interact and reflect on central ideas in the laboratory since they are usually involved in technical activities with few opportunities to express their interpretation and beliefs about the meaning of their inquiry. Teachers not only supply scientific knowledge to their learners, but also know how to engage learners in the processes of problem- solving and applying knowledge to real situation through experimentation."* In other words, they normally have few opportunities for other cognitive activities (Gunstone, 1990).

In the laboratory, learners are challenged to take control of their own learning in the search for knowledge and understanding of scientific concepts. In the process, it is essential to give learners the opportunities that will encourage them to ask questions, formulate hypotheses, and design activities for investigations—"*minds-on as well as hands-on*" (Gunstone,1991).

Barron *et al*. (1998) were of the view that, learners should be provided with frequent opportunities for feedback, reflection, and modification of their ideas in the laboratory. Therefore, experiences in the science laboratory can provide such opportunities for students if the expectations of the teacher allow them to engage in meaningful laboratory experiences upon which they can construct scientific concepts (Penner, Lehrer, & Schuble, 1998; Roth & Roychoudhury, 1993).

2.4.4 The Cognitivist Theory

Cognitive psychologists view learning as an active mental process of acquiring, using and remembering knowledge. Hence, Ashcraft (2006) assumed that mental processes exist that can be scientifically studied and that humans are active participants in their own acts of cognition. Therefore, Butcher (2006) and Mayer and Sims (1994) affirmed that, the information coded for both visually and verbally become easier to learn and remember, and that, the information is available at the same time. Therefore, explaining an idea with words and then representing the concept visually to students has proved helpful to learners.

According to Boulter (1997), a model is one of the ways to represent objects, events or theories. Models are useful scientific teaching tools that can be used in the laboratory to teach abstract concepts. Therefore, developing a model to teach Physical Sciences concepts is a major scientific gain which has played a vital role in learning and exploring various concepts in science.

Cutis and Reigeluth (1983) maintained that the use of visual materials like pictures, drawings, graphs, video or films, real objects, animations and other models in the laboratory, promote learning and improve learner's problem-solving skills. Therefore, teachers who make use of these tools in teaching, reduce cognitive problems in teaching scientific concepts in Physical Sciences.

Furthermore, Schmidt (2001) suggested that it is very significant for the Physical Sciences teacher to adopt and mould the Physical Sciences curriculum to suit the culture and the background of the learner. Thus, Physical Sciences has to be explored in a cognitive framework that stresses the need for the learner to engage in learning and understanding of concepts from laboratory proceedings rather than memorising laid down scientific facts, laws and principles in textbooks and other sources (Mathew, 1992).

In a similar study, Van den Berg, Katu, and Lunetta (1994) reported that hands-on laboratory activities with learners improve their understanding of relationships among variables. "*Frequently they led to cognitive conflict. However, the carefully selected practical activities alone were not sufficient to enable the subject to develop a fully scientific model*." This finding suggested that the more learners engage with materials, the more they improve their understanding of scientific concepts.

Hence, the implementation of the inquiry learning approach in science has been highly prioritize in recent times (Sanger, 2009) and it has been confirmed by research that it can be suitably utilised in the laboratory in all educational levels (Sanger, 2007; Supasorn & Promarak, 2012; Patric & Urhiervwejire, 2012; Pholdee & Supasorn, 2011; Green, Elliot & Cummins, 2004). Supasorn and Lordkam (2014) therefore suggested that, "*inquiry learning can enhance students' potential to develop their science process skills and higher order cognitive skills, which in turn enhances their conceptual understanding and learning achievement*."

In another study, it was found that inquiry teaching is effective and should be emphasised in schools (Awg, Abdul, & Ahmad, 2010).

According to Saksri and Lordkam (2014), inquiry learning effectively engages students in the inquiry questions and provides opportunities for students to explore their answers through their own experiences.

In addition, learners are able to formulate their own explanation from the data collected during inquiry and relate their finding to daily life activities (Balcil, Cikiroglu & Tekkaya, 2006). These opportunities gradually enhanced their understanding of the scientific concepts and then increased their performance in Physical Sciences. Furthermore, utilising learning activities based on their environment effectively engaged learners in active learning in science (Pholdee & Supasorn, 2011).

Furthermore, Kipnis and Hofstein (2007) and Patric and Urhievwejire (2012) were of the view that, inquiry learning is effective to promote active participation, meaningful learning, retention in learning, conceptual understanding and learning performance, as well as improving learners' attitudes towards learning science(Deters, 2005).

Consequently, Supasorn and Lordkam (2014) concluded that implementation of inquiry learning is effective to promote learners attitudes towards learning Physical Sciences which consequently increases their conceptual understanding and learning performance. They therefore advised that, "*Inquiry learning activities should be utilised throughout the science curriculum to support learners' capabilities to improve their scientific process skills and to construct knowledge through the inquiry process"* (Supasorn, S., & Lordkam, A: 2014).

It behoves therefore that, all stakeholders of education and other interest groups in education to pull all resources for the advancement of Physical Sciences education in high schools in South Africa.

2.5 THE ROLE OF SCIENCE LABORATORY IN PROMOTING PHYSICAL SCIENCE EDUCATION

In an increasingly complex world, it is imperative for all students to have extensive practice in what it means to act like a scientist. The skills that are significant in science education are needed by every citizen in order to become a scientifically literate person able to function well in a society where science plays a vital role (Huppert *et al*., 2002: 807).

In view of this, Dalton *et al.* (1997) indicated that students learn best by doing. By engaging learners in a variety of learning experiences, they are more likely to gain an in depth understanding of the scientific concepts in the laboratory (Rochelle *et al*., 2000:79).

Furthermore, the laboratory provides learners practice in raising and defining important problems. Learners are able learn the meaning and use of controls in experimentation and gain expert practice in analysing data from problem situations. Therefore, learners are able to test their hypotheses and interpret data (Henry, 1947, as cited by Blosser, 1980). In addition, science laboratory helps in encouraging scientific learning amongst students, and in developing profound interest in the field. The reason is that, the knowledge and skills that learners gain from textbooks and the classroom are insufficient without understanding the processes and learning the methods in the laboratory.

Learning science involves inquiry and investigation into scientific phenomena. Therefore, multiple representations are used as a tool for inquiry in science lessons (Kozma & Russell, 2005). Baird (1990) is one of several researchers who have observed that the laboratory learning environment guaranteed a radical shift from teacher-centred learning to *purposeful-inquiry* that is more learner-centred. In addition, students develop skills in inquiry, problem-solving and psychomotor skills (Tobin, 1990; Gunstone, 1991).

Moreover, laboratories provide opportunities for learners to develop skills in cooperation and communication, essential for introducing students to central conceptual and procedural knowledge in Physical Sciences (Bybee, 2000). Hence, learners develop positive attitude towards science.

As learners practice with materials in the laboratory, they become perfect and that builds their confidence in Physical Sciences. In addition, Blosser made it clear that providing students with variety of practical learning experiences can vary the classroom learning environment and enhance students' motivation and interest to learn Physical Sciences. *If used properly, the laboratory has the potential to be an* *important medium for introducing students to central conceptual and procedural knowledge and skills in science* (Blosser, 1980).

As a result, learners are better able to understand new pieces of information and are able to recognise patterns when presented with numerous, effective examples of resources in the laboratory (Rose & Mayer, 2002). Therefore, learners are able to develop understanding in Physical Sciences as well as cognitive skills based on their observations of the things around them. In view of this, Clough (2002) declared that laboratory experiences:

"Make science come alive."

Furthermore, laboratories provide learners with practice in problem solving and manipulation of apparatus, and also provide the need for learners to learn out-of-school use of the scientific method (Henry, 1947, as cited by Blosser, 1980). These sustain learners' interest and motivate them to learn Physical Sciences.

Kriek and Grayson (2009) reinforced this argument. They indicated that learners develop conceptual understanding and experimental skills when they perform experiments in the laboratory with their teacher. In addition, learners improve upon their understanding when their teacher uses materials and reagents to demonstrate a scientific phenomenon and explain Physical Sciences concepts in the laboratory. The teacher's teaching skills are also improved in the process.

The science laboratory also exposes learners to develop valuable skills, such as making scientific arguments, offering hands-on experiences in conducting experiments (Hofstein *et al*. 2007), reviewing experimental results closely, reasoning logically, and responding to analytical comments.

2.5.1. Access to the science laboratory

Research has shown that, there have been limitations of access to science laboratories in the teaching of Physical Sciences in South African schools. Only

15% of public schools in South Africa have laboratories. However, the number of public schools with laboratories and stocked laboratories declined greatly between 2006 and 2011, according to the South Africa Survey 2010/2011, published by the South African Institute of Race Relations (Jonathan, 2012).

Despite the fact that the number of schools with laboratories and stocked laboratories in South Africa only declined by less than a percentage point between 2006 and 2011, the number of schools with laboratories decreased by 35% and the number of schools with stocked laboratories dropped by 50%. The number of schools with a laboratory stood at 23% in 2006, and then declined to 15% in 2011. The number of schools with a stocked laboratory fell from 10% to 5 % (DoE), 2011).

Consequently, provinces with the lowest number of schools with laboratories were Limpopo and the Eastern Cape, with 6% and 9% respectively. Only 2% of schools in each province had stocked laboratories (NEIMS, 2011).

Meanwhile, the Department of Basic Education (DBE, 2011) has repeatedly stressed the importance of improving the pass rate and the quality of Physical Science teaching and has also emphasised the importance of teacher development and training. Research has shown that lack of resources is a common problem in most South African public high schools (Legotlo *et al*., 2002:115; Mji & Makgato 2006:254).

These studies together with others have revealed that South African public high schools have serious shortage of physical facilities and infrastructures such as science resource centres, laboratories, science equipments, teaching, and learning aids such as posters, charts, audiotapes and computers, and textbooks (Legotlo *et al*. 2002:115).

The findings of these studies taken together have established a simple relationship between science resource availability and achievement in science and have indicated that Physical Sciences achievement gaps in South African public high schools is a function of resource. Conversely, these studies have also established a growing consensus that laboratories, science resource centres, and science equipments have a greater influence on the learners' achievement in Physical Sciences.

Therefore, it is of outmost importance to ensure that science teachers receive sufficient training and are confident and competent in handling all aspects of Physical Sciences. But it is equally important that they have all the resources needed to teach, and this requires access to stocked science laboratories (Jonathan, 2012).

2.5.2 Students attitude and perception of the laboratory-learning environment

Roux (1994: 06) defines attitude to be a positive or negative emotional relationship with or predisposition toward an object, institution, or person. In addition, Brecker and Wiggins (1991: 137) define attitude as enduring non-verbal features of social and physical world, which are acquired through experience and exert a directive influence on behaviour. These definitions revealed that an attitude explains or describes an emotion that influences the behaviour of human beings.

In contrast, perceptions relate to a way of thinking or a point of view. A significant aspect of perceiving objects or people deals with what others think they are or should be (Morris, 1973).

People's ability to react and respond towards certain things depends largely on how they perceive them. Baron and Byrne (1994) were of the view that attitudes shape and modify individuals' perceptions of the world and their social behaviour. Furthermore, Crawley and Koballa were of the view that the belief that an individual holds about the outcome of engaging in a specific behaviour within personal norm help the person forms an attitude towards engaging in the behaviour (Crawley & Koballa, 1994:37 as cited by Kasonga, 2005).

One of the most important goals of science teaching is to instil a positive attitude towards Physical Sciences in learners. Hofstein and Lunetta (1982, 2004) have suggested that the laboratory is a very unique social setting, which, when activities are organised properly has the potential to enhance social interactions that can contribute positively to developing attitudes and cognitive growth in learners.

Nevertheless, the science education literature continues to articulate that laboratory work is a vital medium for stimulating interest, enhancing attitudes, and motivating students to learn science. Learners' curiosity is enhanced during practical work because they help learners to explore and ask questions. Learners' curiosity is at first immature, impulsive, spontaneous, easily stimulated by new things (Lindt, 2000:57). Hence, attitudes influence behaviours and behaviours in turn influence conduct and performance. When teachers support their learners and have positive relationships with their learners, ultimately their learners feel a sense of school belonging and are encouraged to actively participate in all laboratory activities (Hughes & Chen, 2011:278).

Several studies published in the early 1970s and the late 1980s reported that students claimed that laboratory work is enjoyable in science courses and that laboratory experiences have led to positive and improved student attitude, perception and interest in science (Hofstein & Lunetta, 2004). It is noted that laboratory activities have numerous educational benefits for learners who take part in them and these benefits can be evidently demonstrated in knowledge content and skills gained.

This means laboratory activities should be taken in a more positive learning environment and should teach learners to develop academic skills in terms of content and also develop technical skills in handling equipment and making measurements. Hence, Millar suggested that the learning environment is mostly established by the kind of interaction that occurs in the laboratory. The interaction is between teaching and learning approach, the teacher, and the learners engaged in laboratory activities (Millar, 2004:4).

Wickman (2004:332) has shown that the sequence of the laboratory activities to be conducted by the learners is an important factor to determine what has to be learned in terms of content. This is because when activities are in a particular order, they lead to a particular results and this can be an indicator to the learners of what is important.

Another study by Berg, Christina, Bergendahl and Lundber (2003:363) directly compared a single experiment presented in expository and inquiry formats. The finding suggested that the experiment through inquiry resulted in a more positive outcomes, with regards to learning and perception of the experiment. Such a positive outcome contributes heavily to a positive learning environment. This is because, in inquiry experiments, learners take ownership of their studies as they work through the activities.

Another important factor to consider in enhancing positive learning environment is to design laboratory activities in such a way that less emphasis is placed on assessment. This allows the learners to concentrate on the activity at hand and its implications for science teaching and learning (Vianna & Johnstone, 1999: 285).

In a similar study on learning environments, Lin and Tsai (2009:193) concluded that "*learning environments that are learner-centred, peer interactive and teacher-facilitated, help students develop more fruitful conceptions of the learning environment than other methods".*

2.5.3 Practical investigations and experiments in the laboratory

Over the years, many researchers have argued that science without practical experiences in the school science laboratory is meaningless (Hofstein & Mamlok, 2007). Practical investigations and experiments form an integral part of the formal assessment programme in the new curriculum (CAPS) which was implemented in all schools in South African in January, 2012 (DoE, 2011).

"Practical activities" as used in this study will refer to practical demonstrations, experiments, or projects used to strengthen the concepts being taught.

"Experiment" will refer to a set of outlined instructions for learners to follow in order to obtain results to verify established theory.

"Practical investigations" will require learners to go through the scientific process (DoE, 2011:9).

Scientific investigations are scientific tasks that require learners to plan and conduct an investigation (Mbano, 2004:105). Scientific investigations are vital component of the Physical Sciences curriculum (Mbano, 2004:105). In addition, Hackling and Fairbrother (1996:26) define scientific investigations as;

"*A scientific problem, which requires the student to plan a course of action, carries out an activity and collects the necessary data, organise and interpret the data, and reach a conclusion.*"

According to the Department of Basic Education (DoE, 2011):

"*Practical investigations and experiments should focus on the practical aspects and the process skills required for scientific inquiry and problem solving. Assessment activities should be designed so that learners are assessed on their use of scientific inquiry skills, like planning, observing, and gathering information, comprehending, synthesising, generalising, hypothesising, and communicating* *results, and conclusions. Practical investigations should assess performance at different cognitive levels and focus on process skills, critical thinking, scientific reasoning, and strategies to investigate and solve problems in a variety of scientific and everyday contexts."*

Hence, the difference between a practical investigation and an experiment is that an experiment is conducted to verify or test a known theory whereas an investigation is an experiment that is conducted to test a hypothesis, that is, the result or outcome is not yet known beforehand (DoE, 2011).

Therefore, teaching Physical Sciences requires learners to have hands-on, minds-on experience in experimenting (Fogle, 1985). In addition, the most important features of effective Physical Sciences teaching and learning are laboratory activities that enable learners to take part in the actual teaching and learning process (White & Tisher: 1986).

This was affirmed by Yager (1981), who suggested that science educators should treat experimental work as the '*meal - the main course*' rather than an '*extra or the dessert after a meal*'. In other words, practical activities should form part of Physical Sciences teaching and learning.

According to Bajah (1984 as cited by Abimbola, 1994), '*all science teachers and students know that experimental work is the 'gem' of science teaching'* and therefore, should be integrated with theoretical teaching to strengthen the concepts being taught (DoE, 2011).

Furthermore, Physical Sciences as a subject has its concepts linked with practical investigation. Therefore, Physical Sciences requires scientific evidence to be demonstrated and any other theory to be validated. Hence, the main aim of teaching science is to enhance scientific thinking in learners; a mind which requires learners to test out their hypotheses, through experimentation (DoE, 2011).

Therefore, the understandings of scientific concepts are enhanced through experimentation (Barton, 2004).

In view of this, Duit *et al*. (2007:60) advised science teachers on planning of laboratory activities. He stressed that teachers should provide opportunities for learners to come into contact with the real materials and this will promote cognitive growth in learners as they interact and engage with the materials.

The following serves as a guide when planning and conducting a scientific investigation (DoE, 2009):

- Develop the hypothesis;
- Plan and design the experiment;
- Manipulate equipments, measurement, and make observations;
- Present the data; and
- Analyse, conclude, and evaluate the data.

Duit *et al*. (2007) further argued that laboratory work should be designed to:

- increase learners' motivation to learn.
- improve learners' participation in the activity.
- to develop in learners the ability to link theory to practice in such a way that, learners can weigh the magnitude of deviation that exists between the abstraction and the reality.
- improve learners' achievements in science.

In view of this, science resources must be available and used in science lessons to improve the teaching and learning of science. Hence, laboratory work requires careful planning and considerable knowledge and skills on the part of the physical science teacher (Archer, 2006: 38).

2.5.4 The role of experiments and practical investigation in Physical Science education

Laboratory work has been the most important feature at all levels of school science (Hofstein *et al*., 2007). Experiment performed in the science laboratories is one of the most important activities in the laboratory. Experimenting is an integrated science process skill (Chang & Weng, 2002:441, and Rambuda & Fraser, 2004:11). This is because experiment focuses on the development of practical skills by using a variety of process skills in conducting the practical work in the science laboratory. Rambuda (2003:95) further reinforced this assertion. He viewed experimental work as an opportunity where learners can apply all the process skills to design a hands-on activity to seek for scientific knowledge and understanding of scientific fact.

According to the constructivists, learning is viewed as an active participation of the learner, who engages in learning activities to construct his/her knowledge. Therefore, experimentation in the science laboratory provides learners the opportunity to construct scientific knowledge based on their involvement in designing the experiments, manipulating data, observing outcomes of the experiments, and making inferences and generalisations (Ali Khalfan, & Hassan 2005).

To further strengthen the argument that experiments are very important in science education, Etkina *et al*. (2002: 352) suggested that learners benefit from experimental work through observations of scientific phenomenon, where learners collect data, devise explanation for the data, test their explanations and then apply the concept that they have devised and test to explain other phenomena.

In view of this, Tamir *et al*. (1992), suggested that the science laboratory should not only be seen as an organisational setting where scientific concepts can be verified and demonstrated, but also as a place where learners' process skills can be developed. Hence, learners use their previous experience, knowledge, and skills to perform science processes successfully during experimental inquiry (German & Aram, 1996:777).

Greenwald (2000:28) affirmed this. He states that when learners are faced with challenging problems, and being given the opportunity, they are able to carry out an experiment to solve the problem. By so doing, they acquire knowledge and learn best.

In addition, Henry (as cited by Blosser, 1980) indicated that discussion of a topic in the classroom often follows by laboratory work. The primary aim of conducting an experiment is to obtain evidence which may help to resolve a problem. Very often, scientific methods are used to design and conduct laboratory experiments in order to acquire knowledge and skills, in contrast to the practice of carrying out experiments for the mere purpose of verification.

Researchers all over the world confirmed that, experimentation involves learning by doing. Therefore, experimenting is the only way that an activity-based concept could be taught. Hence, experimentation in schools forms an integral part of quality teaching and learning in Physical Science education (Blosser, 1980)

Henry further identified five main purposes of laboratory experiments in science teaching (Adapted from Henry, 1960, as cited by Blosser, 1980):

- to add reality to textbook materials;
- to experience first-hand familiarity with tools, materials, and techniques of science;
- to allow students to demonstrate concepts in science that they know to be true;
- to give opportunities to learners to use their laboratory skills in seeking experimental answers; and
- to create opportunities for learners to predict outcomes of a task and then design experiments to test out their predictions to determine their accuracy.

Hudson further reinforced this assertion. He indicated that, engaging learners in practical experiments has several advantages (Hudson, 1992:117). These include the following:

- To stimulate learners interest, and motivate them to learn science;
- To enhance the acquisition of scientific knowledge;
- To gain laboratory skills;
- To provide learners with experiences of conducting scientific investigations; and
- To develop positive scientific attitudes in learners.

The National Curriculum Statement (CAPS) Physical Sciences aims at equipping learners with investigating skills such as designing an investigation, drawing and evaluating conclusions, formulating models, hypothesising and problem-solving (DBE, 2011). Hence, practically testing the theories in experiments is vital to acquiring scientific knowledge, skills and understanding scientific concepts. However, it is evident from research that few schools in the country have laboratories and stocked laboratories. Therefore, the benefits of experiments mentioned above are definitely compromised in these disadvantaged schools as they are certainly needed in the teaching and learning of Physical Sciences.

2.5.5 Impediment to effective practical work in the laboratory

Acquiring process skills in Physical Sciences is fundamental in science teaching and learning. In other words, through practical work in the laboratory, learners acquire process skills in Physical Sciences. However, several factors impede practical activities in the laboratory (De Jager & Ferreira, 2003).

A study by Muwanga-Zake (2005) confirmed that most teachers do not engage their learners in practical activities in the laboratory due to their inability to operate on available science equipment like the ticker tape timer.

Furthermore, lack of science resources in most South African schools have led to a situation where Physical Sciences teachers have adapted the use of traditional teaching approach (teacher-centred) in teaching science (Meier, 2003:232). Hence, learners are forced to memorise experimental procedures instead of experimenting themselves. Therefore, the teaching of Physical Sciences has remained at the theoretical level, since teachers do not conduct experiment with their learners to improve their understanding of scientific concepts and application of knowledge (Mji & Makgato, 2006).

In addition to the above, there is always pressure on teachers to cover content and focusing on end- of- year examinations. According to Abd-El-Khalik and Lederman (2000:670), there is poor output of science learners in South Africa and pressure is always on science teachers to improve the performance of learners in Physical Sciences. This has forced teachers to use different strategies to ensure that learners improve upon their results, and this has compromised experimental activities in the laboratory.

In a similar study done by Psillos and Niedderrer (2006: 2-3), the following were revealed as some of the factors that affect effective laboratory work in Physical Sciences:

- Poor laboratory practices that is insufficient and ineffective.
- Poorly designed and planned laboratory activities that are organised for learners, to such a point that learners end up manipulating equipment instead of manipulating ideas.
- Furthermore, much time is usually wasted in the laboratory when learners engage in activities without knowing why they are doing so, since learners are not given adequate opportunities for processing and analysing their data.

McGarvey (2004:17) argues that the level of learning in the laboratory is limited to the curriculum and that learners do not understand the aims and objectives of doing practical work and are not sure of what the outcome of their activities might be and how they will apply the outcomes in learning. In addition, Nakhleh, Polles, and Malina (2002:61) argue that the traditional method of doing practical work where learners resort to following lay down laboratory procedures often leaves little room for creativity or contextualisation.

2.6 The role of science resource centres in promoting teaching and learning of Physical Sciences

The main focus for the establishment of the science resource centres is on the advancement of mathematics and science teachers' subject competence and teaching skills in South African schools. It offers a model whereby South Africa can advance in the area of science education through the effective use of information and communications technology (ICT). Furthermore, science resource centres expose students to science and technology in a fun and relaxed environment by providing learners with classrooms, fully equipped science laboratories, interactive science exhibitions that enhance their thinking skills and curriculum-linked science (Makanjee, 2013), and also, it provides training for teachers to improve their overall teaching abilities.

In addition, the science resource centres were established to help the Department of Basic Education meets it goal of exposing learners to ICT and to give teachers access to quality teaching resources. Moreover, ICT offers opportunity to expose teachers who previously had or no access to technology, to modern technology (Makanjee, 2013). However, these interventions are not only expected to improve learner performance in Physical Sciences in the schools, but are also expected to ensure that learners pursue these subjects at tertiary levels.
Most of the science resource centres are connected to Virtual Private Network (VPN). This serves as a pipeline for information that connects and delivers content to participating schools, learners and teachers, and provides a platform for creating a community of teachers who could communicate as well as share ideas and resources (www.digitalclassroom.co.za).

Moreover, the science resource centres are usually coupled with professional development programme that addresses content knowledge and the effective use of equipment through workshops and classroom support. The centres also help high school science teachers improve upon their content knowledge and pedagogical skills in sciences, and also provide professional development programmes for teachers of Physical Sciences (www.digitalclassroom.co.za). In addition, the centres provide support to science teachers and students at all grade levels with special demonstrations to nurture curiosity and stimulate interest and motivation.

2.7 ICT AND SCIENCE PRACTICAL WORK IN THE SCIENCE RESOURCE CENTRE

Information Communication and Technologies (ICTs) are enabling technologies which include both hardware and software's necessary for delivering of voice, audio, videos tax and internet service from one point and associated equipment's that are connected via internet proto cold and non IP network (Aluko, 2004).

The use of ICT in acquiring knowledge and skills is a very significant component of education and training at all levels of education in South Africa (Emanuel, 2007:1).

Researchers have convincingly argued that information technology has drastically changed the science laboratory activities (Scanlonetal: 2002).The nature and the activities organised in the science laboratories have been changed by the introduction of two new technology-intensive automations: simulated laboratories (McAteer *et al*. 1996) and remote laboratories (Albuetal.2004; Canfora *et al*., 2004) as substitutes for the traditional hands-on laboratories. These new technology-intensive forms of science laboratories are viewed by some scholars as a means to promote science education and making science possible for everyone (Ertugrul 1998; Hartson *et al*. 1996; Raineri 2001; Striegel 2001) and by others as inhibiting science education (Dewhurst *et al*. 2000; Dibiase 2000)(as cited by Jing & Jeffrey, 2006).

Teacher's motivation to use ICT in the science laboratory is at present adversely influenced by lack of time to gain confidence and experience with technology and limited access to reliable resources, overloaded content science curriculum, and lack of specific guidance for using ICT to support learning. However, a teacher tends to use ICT to support, enhance, and complement existing laboratory practices rather than reshaping subject content and pedagogy (Hannatu, 2014).

Furthermore, learners engage in scientific inquiry through the use of computers (Van Joolingen, De Jang, & Dimitrakopoulou, 2007). Hence, reinforcing this argument, researchers suggested that learning science through inquiry by use of computers has positive effect on learners' conceptual understanding of the subject (Salovaara, 2005; Taasoobshirazi *et al*., 2006). However, there are few studies which compare the relationship between achievements of students' performing tasks in a real laboratory, to that, in a virtual laboratory, in which inquiry learning is implemented in both situations (Zacharia, 2007). These studies support the view that virtual experimental laboratory has positive effect on learners' ability to conceptualise scientific concepts as compared to real experimental laboratory (Van Joolingen, De Jong & Dimitrakopoulou, 2007; Zacharia, 2007).

Rose and Meyer (2007: 522) argue that the new ICT application - digital media, facilitates a well-designed environment because of its flexibility. In addition, they indicated four characteristics of digital media that are applicable in the laboratory: versatile, transformable, marked, and can be networked. Evidence shows that the use of digital media promotes the understanding of Physical Sciences concepts, enhances the development of scientific reasoning, and sustains learners' interest in the subject.

There are different kinds of ICT application used in Physical Sciences education that promote science learning in the science resource centres. These include simulations, modelling, multimedia, video authoring, and data logging.

2.7.1. Learning science with simulations and modelling in the science resource centre

Computer simulations are programmes that contain a model of a system. The operational models include series of cognitive and non-cognitive procedures that can be applied to the system (Ton de Jong & Wouter R, 1999). Bransford *et al* were of the view that simulation software involves imitating imaginary situations by using the computer to represent the situation through mathematical models with which the user interacts. The user responds to situations presented by the programme to affect some particular outcome. With practice and continuous use, the learner is able to determine the variables which the programmer has uploaded into the system, and replay their performance to try out possible improvements (Bransford, Brown, & Cocking, 2000).

Furthermore, simulations are interactive software programs that provide opportunities for students to simulate situations while learning (Alessi & Trollip, 2001), for example, in Physical Sciences experiments. They also serve to protect students from dangerous situations, such as exposure to toxic chemicals, and allow students to manipulate impossible situations, and explore phenomena that are too difficult to investigate experimentally and things too small to be seen, for example, the atom(Kim, 2010). Students dynamically manipulate variables to change the situation. In the process, they help to explore situations, solve investigative problems, and understand scientific concepts.

Modelling software differs from simulation software in that the computer provides the tools to create a model for a real or non-real situation. It provides students with the opportunity to visualise, design, and control an experiment (Bransford *et al*., 2000; Riel, 1998). When used in such a situation, the computer follows the instructions provided by the learner. The learning situation revolves around the task of creating the phenomena and the instructions to investigate those phenomena.

Modelling extends the scope of learning from purely exploratory to include a range of interesting activities (Ogbom, 1998). Modelling provide learners the opportunity to change a variable in a scientific system and see their effect. They then learn how to manipulate simple models and progress to making their own models (Barton, 2004).

Furthermore, Margaret Cox has reviewed research carried out over the past two decades on the educational use of ICT-based simulations and modelling, and concludes that the main advantage of teaching learners with simulations and modelling is to promote the acquisition of investigative skills and to enhance learners understanding of scientific concepts and processes (Cox, 2000).

The different kinds of simulation and modelling activities allow the learner to expressive and exploratory learning activities (Mellar & Bliss, 1994). Exploratory learning activities require the learner to explore ideas of a particular task where the ideas of the learner may often be quite different from the ideas of the teacher.

2.7.2 Learning science with data-logging in the science resource centre

Data-logging methods involve the use of electronic devices to sense, measure, and record physical parameters in experimental settings. Measurement can be made and displayed almost instantly on the computer screen. Hence, the data collected in these ways can be illustrated in tables and graphs (Newton, 2000).

Data-logging software is an important application in Physical Science education since it forms the link between practical work and the use of ICT in the science laboratory. Using and interpreting information from secondary sources are also important activities in science education, for example, activities involving searching and using information from CD-ROM databases and the internet (Barton, 2004). Computer technology has enabled an exploration into the available ways to present material. These materials are central to web-based and multimedia instruction.

2.7.3 Learning science with multimedia in the science resource centre

Multimedia instruction makes use of different media; mostly, visual and auditory media to present educational content. The information is presented in verbal form, in addition to pictorial form in order to enhance meaningful learning (Mayer, 2009: 5). Mayer further identifies two ways of designing multimedia material. The first approach centred on technology and the second approach centred on the learner. The technology-centred approach uses the latest available technology to determine the effective technology to present information. However, this approach does not lead to any improvement in Physical Science education.

In contrast, the learner-centred approach emphasises on human cognition in line with how the mind works. It has been asserted that the use of textbooks to enhanced learning is equally effective when using the electronic resources. According to Mayer (2003a: 298) "*the same design principles that promote learning in traditional environments are likely to promote learning in electronic environments.*"

2.7.4. The role of ICT in the teaching and learning of Physical Science

A citation of Hannatu (2014 of Amajuoyi 2012) summarised the roles of ICT in Physical Science education as follows:

- Promoting learners' intellectual qualities through higher order thinking, problem solving, improved communication skills and deep understanding of the learning tools and concepts to be taught.

- Promoting a supportive, interactive teaching and learning environment by creating broader learning communication and therefore providing learning tools for students especially those with special needs (Amajuoyi, 2012, as cited by Hannatu, 2014).

Introduction of ICT in Physical Sciences lessons can enhance learners' levels of knowledge and also raise learners' attitudes toward the subject (Haunsel & Hill, 1989; Kubiatko & Halakova, 2009). ICT usage in the science resource centres is very important for providing opportunity for learners to learn to operate in a technological world (Khalid, 2009). Dawes (2001) is of the view that ICT has the potential to support education across the curriculum and provides opportunity for teachers and learners to communicate effectively. In addition, ICT assists learners to become knowledgeable, and hence, reduces the amount of instruction given to them by the teacher, and gives the teacher an opportunity to assist learners with various educational needs (Iding, Crosby & Speitel, 2002, Shamatha, Peressini & Meymaris, 2004; Romeo, 2006).

ICT use in Physical Sciences teaching assist learners to develop methods for problem solving, by building models and creating new rules (Boohan, 1994). As such, they are able to complete all tasks of complex cognitive level than they would be able to do without the use of the software (Wideman & Owston, 1988).

Hitchcock (2001) is of the view that ICT enables teachers to give individual attention to each student to ensure that every learner functions within his or her "*zone of proximal development*". He further alluded that boredom and frustration in learners are prevented in the science laboratory and school has become a place of high productivity and achievement for almost everyone when ICT is used in teaching Physical Science.

Hussain (2008:51) further confirms this by pointing out that the use of ICT promotes students' access to extensive databases. Hence, they share their own work through networked communications, while working on collaborative projects. Students are able to reason, and respond to analytical comments. These skills are valuable skills to be developed and are useful and applicable in any discipline (Hofstein *et al.* 2008:1).

Furthermore, Osborn and Hannessy (2003:19) pointed out that *ICT 'offers the opportunity to dissolve the boundaries that demarcate school science from contemporary science by facilitating access to a wide body of data'*. They further suggested that the use of ICT in science laboratory can facilitate procedural knowledge. Procedural knowledge is the expertise of knowing 'how' to do something, over and above knowing 'what' something is. Hence, one unique feature of this knowledge is the ability to transfer in other situations (Osborn & Hannessy, 2003).

Science is a practical subject which involves real-life activities. Learning in the science laboratory therefore entails '*observing, measuring, communicating and discussing; all these aspects should be made attractive and engaging to students'* (Wellington, 2000:196).

2.8 The link between science resources and learner performance in Physical Sciences

Researchers have had a contested issue on whether science resources have an impact on learner performance in Physical Sciences. Hallack emphasised that when resources are available, relevant, and adequate, they improve the academic achievement of learners in Physical Sciences (Hallack, 1990 as cited by Adeogun, 2008: 145).

However, Hanushek (2002, 2003 as cited by Mangan, Hurd & Adnett, 2007:4) rejected this view. He claimed that the total level of school science resources is not closely related to student performance in Physical Science.

Similar research studies have been conducted to investigate the educational effectiveness of laboratory work in Physical Sciences education in facilitating the attainment of the cognitive, affective, and practical goals. These studies have been critically reviewed in the literature (Hofstein & Lunetta 1982; 2004; Blosser, 1983; Bryce & Robertson 1985; Hodson, 1993; Lazarowitz & Tamir 1994). From these reviews, it is evident that in general, although the science laboratory has been given a central role in Physical Sciences education, research has failed to show simple relationships between experiences in the laboratory and student performance in science.

In his view, Hodson has criticised laboratory work and claimed, the laboratory work is not beneficial to the learners, confusing, with no thought-out objectives, and he called for more emphasis on what students are actually doing in the laboratory (Hodson, 1990, as cited by Hofstein & Mamlok, 2007). Hodson (Hodson, 1990, as cited by Hart *et al*., 2000) further argued that, the laboratory work is often dull and teacher-centred and learners often failed to relate the laboratory work to the theoretical aspects of their learning to enhanced understanding, resulting in an improved performance.

In another study by Naidoo and Lewin (1998: 729), they indicated that, learner performance is not only determined by the availability of resources but also by the effective use of the available resources by the science teacher. South Africa has implemented many educational policies to address the issue with science education and science performance. According to Naidoo and Lewin (1998), the focus of these policies have been to educate more science teachers, providing access to students to study science at schools, and supplying and distributing science resources to all schools to improve learner performance in Physical Sciences.

Furthermore, the most important feature of laboratory teaching is the ability of the learner to select and use what is relevant for the task at hand and discard what is not needed (Hindal, Reid & Badgaish 2009: 199-189).

Lack of school-based resources is also another factor that can affect poor performance in Physical Sciences. In many public schools in South Africa, there is a lack of proper laboratory facilities; hence, Physical Sciences concepts become more difficult for learners to learn. In view of this, the subject remains at a very theoretical level without any experiments to promote the understanding of content and application of knowledge (Makgato & Mji, 2006:254).

In addition, Fonseca and Conboy (2006) noted that reasonable laboratory activities enhance students' interest and achievement in Physical Sciences. In addition, the results of the findings agreed with that of Mutai (2006) who asserted that learning is strengthened when teaching resources are readily available and further asserted that academic achievement illustrates the correct use of these available materials.

The findings of these studies taken together established a compelling relationship between science resource availability and performance in Physical Sciences. The findings have indicated that Physical Sciences achievement gaps in South African schools are a function of resource. However, these studies have also established a growing consensus that laboratories and science resources have a greater impact on the learners' achievement in Physical Sciences than other resources in a school.

In reviewing the literature, Hofstein and Lunetta (1982) wrote that it was difficult to identify a simple relationship between students' performance in Physical Sciences and their work with materials in the laboratory.

2.9 SUMMARY

This chapter began with conceptualisation of key concepts central to the study, namely, teaching and learning processes and the learner performance in science with emphasise on the use of science laboratory and science resource centres. An attempt was made to give subjective difference between the two terms. The chapter also looked into the theoretical framework and educational theories and their implications in Physical Sciences teaching that suggest the need for science resources in promoting learning in the subject.

The chapter also highlighted on an extensive literature review on the use of science resource centres and laboratories for teaching Physical Sciences, which have been a concern to the science education community for many years. Most researchers have conducted studies into the use of science resources and laboratories to improve Physical Sciences education since the early 1900's.

Despite this on-going research, researchers in the field of science and science education have not been able to provide enough evidence in support of the contention that laboratory work improves learner performance or laboratory work has no contribution in learner performance in Physical Sciences education. There is a large amount of opinion literature in favour of the use of the laboratory and science resource centre to improve science education. However, there are critics of the use of the laboratory, in the science education community.

The chapter also looked into the possible role of ICT usage in the science resource centres and the laboratory to improve learner performance in Physical Sciences education.

Finally, the chapter also looked at the link between use of science resources and learner achievement in Physical Sciences. Therefore, it behoves that all stakeholders of education and other interest groups in education to pull all resources for the advancement of Physical Sciences education in schools.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter focuses on the different research designs and methodologies used for the study. The purpose of the study was to examine the use of science resource centres and science laboratories to improve learner performance in Physical Sciences. In this regard, this chapter describes the research design; provides a brief overview of quantitative research methods; it describes sampling and sample criteria; it explains the research instruments; and describes how data was collected and analysed.

3.2 RESEARCH METHODOLOGY

Methodology refers to the diverse ways of obtaining, organising, and analysis data (Polit & Hungler, 2004: 233). In addition, methodology may be defined as a coherent group of methods that complement one another and that have the ability to fit to deliver data and findings that will reflect the research question and suit the researcher purpose(Henning 2004:36). Therefore, it includes the design, setting, sample, data collection, and analysis techniques in a study (Burns & Grove, 2003:488).

3.3 RESEARCH DESIGN

The term research design refers to a plan for selecting subjects, research sites, and data collection procedures to answer the research question (McMillan & Schumacher, 2010: 117). A research design establishes and describes the methods and a step a researcher follows in finding out information about the area the researcher is studying (McMillan & Schumacher 2010:20). Similarly, Henning, Van Rensburg, and Smit (2004:36) affirmed this view. They defined research design as a conceptual model or a well-designed idea of what the product of research is expected to look like.

The rationale for a sound research design is to provide results that are judged to be credible and to elicit the views of the subjects on issues the researcher is interested in. This will enable the researcher to offer suggestions and recommendations on the use of science resource centres and laboratory to improve upon teaching and learning of science in the secondary schools. Research design enables researchers to answer research question as validly, objectively, accurately and economically as possible (McMillan & Schumacher, 2010: 117).

Hence, two types of research designs used in most educational research are quantitative and qualitative methods. Quantitative research explains phenomena by collecting numerical data and analysing it using number-based methods (Johnson & Christensen, 2004:31-32; Muijs 2004:1). In contrast, qualitative research, explores opinions of individuals and settings that cannot be described easily with numbers (De Vos, 1998:15) and is more concerned with understanding the social phenomenon from participants' views than explaining a phenomenon (McMillan & Schumacher, 2001:17; De Vos, 1998:242). In this study, a multiple research method was used, which comprises; quantitative and qualitative research design.

3.3.1 Quantitative Design

Quantitative research is one in which the researcher primarily uses post positivist claims for developing knowledge. These include cause and effect thinking; reduction to specific variables and hypothesis and questions; use of measurement and observation, and the test of theories; employs strategies of inquiry such as experiments and surveys; and collects data on predetermined instruments that yield statistical data (Creswell 2003:18).

Furthermore, quantitative research is a study that involves collection and analysing numerical data, which is concerned with the relationship of one set of variable to another (Bell 2005:13; Gay *et al*. 2006:9). Here, a process is expressed or described in terms of one or more variables. The result of this research is essentially a number or a set of numbers.

Moreover, quantitative research generally focuses on hypothesis testing. Therefore, one or more variables are studied at a time, thereby, seeking to reduce data to numbers that represent a single criterion (Johnson & Christensen, 2004:30-33; Best & Kahn, 1993:186).

Consequently, quantitative research is classified as either experimental or non-experimental design (Muijs, 2004:13; McMillan & Schumacher, 2010:23). Experimental research is *"a test under controlled conditions that is made to demonstrate a known truth or examine the validity of a hypothesis*" (Muijs, 2004:13). Experimental research method is designed to study casual relationships between variables (Johnson & Christensen, 2004:263). Conversely, non-experimental research design describes things that have occurred and determines relationships between variable without any direct manipulation of conditions (MacMillan & Schumacher, 2010: 24). The study followed a non-experimental quantitative design.

In non-experimental design, there is no control of conditions, variables, and extraneous influences (Johnson & Christensen (2004:328). The variables are used as they appear in practice. Non-experimental research methods include*;* descriptive, comparative, correlation, survey research, ex post facto and secondary data analysis (McMillan & Schumacher, 2010:25). This study followed a survey research design.

3.3.1.1 Survey Design

In a survey, the researcher selects a sample of respondents from a larger population and administers a questionnaire or conducts interviews to collect information on variables the researcher is interested in (McMillan& Schumacher, 2010: 233). According to Gay *et al*. (2006:10), a survey involves data collection to describe conditions by allowing the researcher to generate new knowledge and ideas from the subject of the study through intensive reveal of a phenomena. The intention of surveys as further proposed by Bell (2005:13) and Robson (2007:41) is to describe the incidence, frequency, or distribution of characteristics of an identified population.

Hence, surveys are used to learn about people's attitudes, beliefs, values, demographics, behaviours, opinions, habits, and desires (McMillan & Schumacher, 2010: 233). Furthermore, surveys are also used in educational research because, accurate information can be obtained from the population, and data can be generalised (McMillan & Schumacher 2010:233).

Therefore, this study is based on the survey design which provided in-depth information on the ideas, opinion, attitudes, and beliefs about the use of science resources and laboratories to improve learner performance in Physical Sciences.

3.3.2 Qualitative Design

The study also used qualitative research methods. Qualitative research generally attempts to understand the issues from the viewpoints of the respondents (Bryman, 1988 as cited by Struwig & Stead 2007:12) Qualitative research as explained by Leedy (2005:133) as the approach that focuses on phenomena that occur in the natural settings and also involves studying those phenomena in all complexity. A qualitative research method is characterized by its natural setting; the setting was the school which included classrooms, the science resource centres, and the laboratories which could be necessary to support the schools instructional programme. This was more appropriate as the researcher attempted to understand the behaviour of respondents as it occurs without external constraints and control.

3.4 RESEARCH SITE

Research site refers to a place selected for gathering data about the problem being investigated by a researcher (McMillan & Schumacher, 2010: 326). This study investigated the use of science resources and laboratories to improve Physical Sciences education in Mthatha. The researcher purposefully selected seven (7) high schools; five public high schools; and two private high schools where learning of Physical Sciences takes place. The selection of schools for this study was based on the knowledge of the researcher being a Physical Sciences teacher in Mthatha. The seven high schools selected for this study were both located in Mthatha Township, Mthatha District. These schools shared the following features: they are all mixed schools; and they serve a medium socio-economic area. They all use English as a medium of instruction.

All the five public high schools were far apart from each other, with the exception of the two private schools that share a wall. Each of these schools have spacious classrooms but may have or not have a science laboratory and may have or not have visited a science resource centre ever before.

3.5 POPULATION

A population is a group of individuals with specific criteria and to which we intend to generalise the results of the research (McMillan & Schumacher, 2010: 119). Subjects (participants) are the individuals who take part in the study, and from whom data are collected (McMillan & Schumacher, 2010: 119). The target population is the entire group of individuals having the characteristics that the researcher is interested in (McMillan & Schumacher 2001:169, Johnson & Christensen 2008:224).

The study targeted school principals, Physical Sciences teachers, and learners in both public and private high schools in Mthatha. In view of this, the generalisations of the results for the study were made from the senior secondary schools Physical Sciences learners and educators from Mthatha.

3.5.1 Sampling

Sampling refers to a process of selecting a small portion of the population to represent the entire population for the study (Johnson & Christensen 2008:222, Vogt, 2007:77). A sample is a number of people taken from the wider population so that it would be possible to make generalisations that are unbiased (Robson 2007:98). Due to the number of high schools in Mthatha, and their class sizes, it was impractical and unnecessary to measure all the individuals in the target population (McMillan & Schumacher 2001:170), and as such, a sample of five public high schools and two private high schools were selected.

3.5.2 Sampling criteria

There are several sampling techniques used in educational research. These are probability and non-probability sampling techniques. In probability sampling, subjects are drawn from a larger population in such a way that the probability of selecting each member of the population is known (McMillan & Schumacher, 2010: 127).

The different types of probability sampling techniques include: simple random sampling, systematic sampling, stratified random sampling, cluster sampling, and multistage sampling. In non-probability sampling, the researcher uses subjects who happen to be accessible or who may represent certain types of characteristics. The different types of non-probability sampling include: convenience sampling, purposeful sampling, and quota sampling (McMillan & Schumacher, 2010: 127).

In this study, a non-probability purposeful sampling technique was used to select the research sites or the schools. Since this is a survey study, it was in the researcher's interest to choose seven schools (Table 3.1) from all the 23 schools in Mthatha as it was not possible for the researcher to study all the high schools in Mthatha. This sampling represents 33.4% of the public schools and 20% of the independent schools in Mthatha.

Moreover, for the purpose of this study, a probability - stratified random sampling method was used to select the population and to have equal representation of science learners from all schools in terms of numbers per grade, gender and finally, the correct sample size.

Stratified random sampling is a probability sampling technique in which a population is divided into subgroups or strata based on certain variables such as gender, age, grade or level of education. Then samples are randomly drawn from each subgroup in the same proportion in which they exist in the population (Gay *et al*. 2006 :103-104, Johnson & Christensen 2008: 233). Stratified random sampling is more efficient and uses a small number of participants, which results in less sampling error and allow the researcher to compare subgroup results.

The stratified random sampling employed in selecting the sample of subjects involved the following (McMillan& Schumacher 2001:172, Johnson, & Christensen 2008:231). The lists of all Physical Sciences learners were acquired on the first day of the researcher's visit to the schools. From the list, Physical Sciences learners were divided into subgroups based on grade and gender. Names of all the boys per each grade and all the girls per each grade were placed in four containers. The same procedure took place in all seven schools for the study. In a raffle format, a boy's name per grade was randomly selected, followed by a girl's name in the same grade from the other container. This was done to avoid gender bias.

To ensure that there were an equal representation of numbers of learners from each of the five public schools per each grade and that of the two private high schools, the same number of learners were chosen from each public school and from each private high school. As a result, eight (8) science learners were selected from grade 11 of each public school and six (6) learners from the private schools, giving a total sample size of fifty two (52), while five (5) science learners were also selected from grade 12 of each public high school and eight (8) learners were selected from each private school, given a total sample size of 41 learners (Table 3.2). According to Anderson, (1990), the difference between the characteristics of the population and the sample size selected for the study is called 'sample error'. Hence, the larger the sample size, the smaller the sampling error and vice versa.

Table 3.1: Total number of learners per Grade in sampled schools

Total number of learners per Grade in sampled schools							
SCHOOLS	A	B	C	D	E	F	G
Grade 11	85	345	280	96	58	52	72
Grade 12	82	320	124	70	37	33	40
Total	167	665	404	166	95	85	112

Table 3.2: Percentage of learners sampled

PERCENTAGE OF LEARNERS SAMPLED FOR THE STUDY			
	Learners in sampled schools	Sample(n)	%
Grade 11	988	52	56
Grade 12	706	41	44
Total	1694	93	100

Because the population of science educators were significantly small, seven science teachers (Table 3.1) were selected from the seven schools sampled for the study and were used to answer the questionnaire to ensure a meaningful statistical analysis.

Table 3.3: Total number of science teachers in the sampled schools

Total number of science teachers in the sample school			
Category	Number of teachers in the sample school	Sample(n)	%
Teacher	17	7	41.2
Total	17	7	41.2

3.5.3. The sample size

Literature has shown that several factors should be considered when determining the sample size. These factors include the type of research, research question(s), financial constraints, the number of variables to study and the methods of collecting data (McMillan & Schumacher 2001:177; Johnson & Christensen 2008:24). Hence, McKay (2005:12) is of the view that certain characteristics in the target population should be considered when deciding on the size of the population. For this reason, it was envisaged from the entire population that, a hundred and seven (107) individuals were selected for the study. This sample size was adequate and large enough to answer the research questions as well as offsetting any error in terms of provision of the data for this study.

The sample size comprises; seven (7) school principals, seven (7) Physical Sciences teachers and ninety three (93) learners; thirteen (13) learners from grade 11 and 12 of the public schools and 14 learners from each private school, regardless of age and gender.

3.6 RESEARCH INSTRUMENTS

Research involves gathering information about the variables in the study. The researcher chooses from a wide range of instruments for collecting data from subjects. According to Biggam (2011:286), selecting an instrument to collect data is just as important as choosing an appropriate research strategy. O'Leary (2004:162) also affirmed this assertion. He indicated that, the researcher has to select the right instrument for addressing the needs of the research question. Therefore, the researcher has to make a decision and choose the right instrument for the study. Although, each of the instruments has its own advantages and disadvantages, the instrument adopted in this study is the best one for answering the research question.

The study aimed to collect data in the form of a survey and employed the use of questionnaires and semi-structured interviews as the main instruments.

3.6.1 Design of the Questionnaire

A questionnaire is one of the many ways a researcher can obtain information for research purposes. Johnson and Christensen (2008:170) described questionnaire as a self-report instrument that respondents in a research complete as part of a research study. A questionnaire can be designed such that respondents answer statements or questions in writing. Therefore, designing a questionnaire requires careful skills, this is because, the responses given by respondents may affect the way it is designed (Muijs, 2004:45).

For many good reasons, the researcher chose a questionnaire because it is the most widely used instrument for data collection. It is therefore very important to have well designed questionnaires in order to obtain in-depth and more accurate information from respondents (Gay *et al*. 2006:420; Borg *et al*. 2005:313).

There are two main types of questionnaire, namely, open and closed questionnaires. An open-ended questionnaire allows the respondents to use their own words to answer the questions. With open-ended questions, no pre-coded answers, that is, response categories are provided. These questions are particularly useful when it is important to avoid influencing respondents by providing a list of possible answers to choose from. Open-ended questionnaires have certain disadvantages (Potgieter *et al*., 2005):

- Open-ended questions are time-consuming because, questions can only be coded after the survey has been conducted.

- Open-ended questions may often yield unusable information because the respondent does not understand the question.

• The respondents are required to write down their responses. Hence, semi-literate respondents or those who have difficulty expressing their thoughts and ideas, often avoid answering open questions.

Open-ended questions should therefore be used circumspectly and only when necessary. Closed –ended questionnaires are often referred to as multiple-choice questions. In closed –ended questionnaires, response categories are provided and respondents are required to select a particular answer or answers. These are especially useful to indicate the level of detail one expects the respondents to provide (Potgieter *et al*, 2005).

In this study, a closed-ended questionnaire was developed on completion of the literature review. This is because, close-ended questionnaire can encourage 'mindless' replies. It is easy for all literacy levels to respond (http:/www.iboro.ac.uk/services/library/skill). In addition, it is quick to answer, easy to code and analyse and may improve response rates.

When formulating closed-ended questions keep the following in mind (Potgieter *et al*., 2005):

• Each question should contain clear instructions as to how to fill it in, that is, tell the respondent when the question requires only one answer and when more than one answers may be given.

• Ensure that all possible alternatives are provided, that is, the response alternatives should be exhaustive. Use other (please specify) if you are not sure.

• If only one alternative is to be marked, the alternatives should not overlap, that is, the alternatives should be mutually exclusive.

• If the possibility exists that a question does not apply to a respondent, include; Not Applicable as one of the alternatives.

3.6.1.1 Advantages of a questionnaire

- It is the most widely used technique for obtaining data from participants (McMillan & Schumacher 2010:195).
- It can be analysed more scientifically and objectively than other forms of research instruments (Popper, 2004; Ackroyd & Huges, 1981).
- It could be used alongside with other data collection methods in a research study (Johnson & Christensen 2008:170).

3.6.1.2 Disadvantages of a questionnaire

- Those who have an interest in the subject may be more likely to respond, skewing the sample (Potgieter *et al*., 2005).
- Respondents may ignore certain questions.

3.6.2 Content of the questionnaire

The questionnaire was compiled after extensive literature review of related sources. A true Likert scale was used in this study. This allows the respondents to choose from several options indicating levels of agreements or disagreements (McMillan & Schumacher, 2010:199).

The questionnaires were of two kinds, namely, Questionnaire A and B. Response alternative of "*very poor*", "*poo*r", "*average*", "*good*" to "*very good*" were applicable to some items in the questionnaires. However, a response of a "*No*" or a "*Yes*" was limited to few items in both questionnaires since responses were considered unable to provide the viewpoints of respondents.

3.6.2.1 Questionnaire A

Questionnaire A was designed to elicit responses from Physical Science teachers. This questionnaire comprises eight (8) sections.

Section A of this questionnaire focused to elicit biographical information of respondents with regard to gender, overall years of Physical Sciences teaching experience, highest qualifications, and the subject(s) they majored in during their teacher training at the tertiary level. A Likert scale of 1 to 2 was used to determine the gender. A scale of 1 to 9 was used to determine the qualification of the teachers.

Section B of the questionnaire requested for the availability of science resources, infrastructure such as classrooms and laboratories, furniture, science textbooks, laboratory equipments, benches, computers, projectors, scientific models, reagents and apparatus for experimentation, and etcetera within the school as an organisation, adequacy of these resources and access to these resources.

Section C of the questionnaire focused on finding out the knowledge of content of subject matter of science educators and how well science educators are familiar with the principles of CAPS forming the new South African curriculum. Research has shown that most South African science teachers have very little knowledge of the content of the subject (Mji & Makgato 2006:259). The main focus of including this section into the questionnaire is to affirm what research had provided.

Section D of the questionnaire focused on the different teaching and learning methodologies used by Physical Sciences teachers and feedback to learners with regard to tasks. The section further investigated the class size of each science teacher and their work load and how they view their learners with respect to their attitude to Physical Sciences and practical work.

Section E probed for the teachers' skills of planning, teaching, and supervising scientific experiments, and skills of assessing learners' strength and weaknesses. A Likert scale of 1 to 8 was used in this section.

Section F requested the Physical Sciences educators to indicate how they teach practical investigation and conduct experiment with learners. A scale of 1 to 10 was used to determine aspects such as allow learners to work without my intervention when conducting scientific investigation; I conduct experiments with my learners to verify facts taught in class; I derive investigation activities from text books, and etcetera.

Section G covered the use of ICT by teachers in teaching scientific concepts in Physical Sciences. Aspects such as the use of computer simulations to teach science concepts, knowledge of the use of ICT, and importance of ICT usage in science were considered.

Section H was included as an opinion survey to determine the views of respondents about the teaching and learning process in general, their Physical Science department, and the whole school as an organisation. The statements were used to collect data which covered a wide range of aspects such as their workload, recognition of their work, organisation of practical activities and opportunities for professional growth. The table below summarises the content of question A.

Table 3.4: Content of questionnaire A

Section	Themes	Variables
A	Biographical Information	V_1,V_2, V_3, V_4, V_5.
B	Resources available for science teaching	V_6, V_7, V_8, V_9, V_{10}, V_{11}, V_{12}, V_{13}, V_{14}, V_{15}, V_{16}, V_{17}, V_{18}, V_{19}.
C	Knowledge of content of subject matter	V_{20},V_{21}, V_{22}, V_{23}, V_{24}, $V_{25.}$
D	Teaching and learning of science	V_{26}, V_{27}, V_{28}, V_{29}, V_{30}, V_{31}, V_{32}, V_{33}, V_{34}, V_{35}, V_{36}, V_{37}, V_{38}
E	Organisational skills	V_{39}, V_{40}. V_{41}, V_{42}, V_{43}, V_{44}, $V_{45,}$ V_{46}
F	Teaching practical investigation and conducting experiment	V_{47}, $V_{48,}$ V_{49}, V_{50}, V_{51}, V_{52}, V_{53}, V_{54}, V_{55}, V_{56}
G	Use of ICT in teaching science	V_{57}, $V_{58,}$ V_{59}, V_{60}, V_{61}, V_{62}, V_{63}, V_{64}, V_{65}, V_{66}, V_{67}, V_{68},
H	Individuals opinion about teaching science	V_{69}, V_{70}, V_{71}, V_{72}, V_{73}, V_{74}, $V_{75,}$ $V_{76,}$ V_{77}, V_{78}, V_{79}, V_{80}, V_{81}

3.6.2.2 Questionnaire B

Questionnaire B was designed to elicit information from Physical Science learners. It comprises five (5) sections.

Section A requested for the biographical data of the learners. Aspects such as gender, age, possession of a calculator, and punctuality to school were considered. A Likert scale of 1 to 2, 1 to 3, and 1 to 4 were used in this section.

Section B focused on the teaching and learning of Physical Sciences. Aspect such as the language their teachers use when teaching science, the language the learners preferred their teacher to use, rating of their teachers in terms of traits, were considered.

Section C was included as an opinion survey to determine the views of learners about the teaching and learning process in general, and the whole school as an organisation. Aspects such as whether all science learners are treated fairly by their teachers, Physical Sciences lessons are interested enough to keep them attentive and whether their teachers have been teaching them well enough for them to understand scientific concepts.

Section D dealt with the use of ICT in the teaching and learning of concepts in Physical Sciences. Aspects such as the use of computer simulations to teach Physical Sciences concepts, knowledge of the use of ICT, and importance of ICT usage in science were considered.

Section E focused on the factors that influence the use of ICT in teaching and learning of Physical Sciences in schools. In other words, the section attempted to find out whether the government has made ICT infrastructure available to schools, whether the CAPS curriculum supports ICT usage in teaching Physical Sciences. The section also sought to find out whether the Physical Sciences teachers have access to software programmes which are compatible to the CAPS documents. The table below summarises the content of questionnaire B.

Table 3.5: Content of questionnaire B

Sections	Themes	Variables
A	Biographical data	V_1, V_2, V_3, V_4, V_5
B	The teaching and learning process	V_6, V_7, V_8, V_9, V_{10}, V_{11}, V_{12}, V_{13}
C	Individual's opinions	V_{14}, V_{15}, V_{16}, V_{17}, V_{18}, V_{19}, V_{20}, V_{21}, V_{22}, V_{23}, V_{24}, V_{25}, V_{26}, V_{27}, V_{28}
D	Uses of ICT in the teaching and learning of Physical Sciences	V_{29}, V_{30}, V_{31}. V_{32}, V_{33}, V_{34}, V_{35}, V_{36} V_{37}, $V_{38,}$. $V_{39,}$ V_{40},
E	Factors influencing ICT usage in schools	V_{41}, V_{42} V_{43}, V_{44}, V_{45}, V_{46}, V_{47}, V_{48}, V_{49}, V_{50}, V_{51}, $V_{52.}$

3.6.3 Interviews

Gay described interview as the purposive interaction between two or more persons, where one obtains information from the other (Gay, 1992:232). However, it has been concluded by researchers that interview permits researchers to obtain information that cannot be obtained from observations alone. The researcher interviews the participants and records their responses at the same time, which later provides the researcher with a verbatim account of the interview. However, interviews have a number of unique advantages and disadvantages, but Gay (1992:231) points out that when well conducted, it can produce in-depth information that are not possible with any other type of instrument.

In this study, semi- structured interview was used in addition to the questionnaire, to collect rich data from participants (Neuman 1997). Corbetta (2003:270) further explained semi-structured interview as a flexible, expressive interaction, which allows new questions to be brought up during the interview. While Silverman (1993) suggested that a semi-structured interview involves a set of open questions that allow participants to respond spontaneous. Usually, the interviewer in a semi-structured interview generally has a framework of themes to be explored.

3.6.3.1 Advantages of interview

The researcher decided to use interview as data collection gathering technique because of the following reasons as mentioned by Gay (1992:231):

- The interview is most appropriate for asking questions that cannot effectively be structured into a multiple-choice format, such as questions dealing with personal phenomena;
- Interview is flexible; hence, questions can be adjusted to suit the situation of the interviewer; and
- The interviewer establishes rapport and trust relationships with the participants. By so doing, the researcher can often obtain information that participants would not provide on a questionnaire.

3.6.3.2. Disadvantages

However, Bailey (1994:175) points out that the interview can have the following disadvantages:

- Interview can be extremely costly;
- Interview is lengthy and time consuming;
- Participants are not easily accessible. If the respondents are busy, it will not be easy to access them for interview.

3.7 VALIDITY AND RELIABILITY OF THE INSTRUMENT

The validity and reliability of a research study hangs on issues of accuracy and relevance of procedures used for the information collected for the study. Moreover, issues of accuracy and relevance have always been seen as the most important criteria for evaluating quantitative research instruments if the researcher's interpretation of data are to be valuable (Gay *et al*. 2006 :134). In all research studies, it is important and essential to establish the reliability and validity of the research instruments. Hence, according to Vogt, these two terms are often discussed together but they are distinct (Vogt, 2007:113).

3.7.1 Validity

According to Anderson (1990: 12), validity refers to the extent to which a test measures what it is expected to measure and as such, it depends on the purpose of the test. Cook and Campbell (1979) define validity as the "*best available approximation to the truth or falsity of a given inference, proposition or conclusion*". According to Johnson and Christensen (2008 :150-151) and McMillan and Schumacher (2010: 179), validity can be described as whether a particular instrument measures what it claims to measure for a particular group of people in a particular situation and that the interpretations made on the basis of the test scores are correct.

Validity can be improved through careful sampling, appropriate instrumentation, and appropriate statistical treatment of data. In this study, content, construct and face validity of the measuring instruments were considered.

3.7.1.1 Content validity

This refers to whether the content of the questions in the questionnaire is appropriate to measure the concept that the researcher intends to measure (Muijs, 2004:66). An instrument used to collect data must show the characteristics of being fair and comprehensive and measure the items that it is supposed to measure (Cohen *et al*., 2000:109).

A comprehensive search of literature on the use of Physical Sciences laboratories and science resource centres was carried out to achieve content validity. Therefore, items in the questionnaire are a true representation of what it has to measure. The design of the questionnaire was influenced by the time available to the researcher, since most of the longer questions reduce chances of the questionnaire to be completed on time (Muijs, 2004:46). Expert knowledge from colleagues and the supervisor, and pilot study were used to validate the questionnaire.

3.7.1.2 Construct validity

Construct validity deals with the relationship between the internal structure of the instrument and the concept it is measuring (Muijs, 2004:68). Construct validity focuses on the question: *'is the instrument measuring what one intends to measure'*? (Vogt, 2007:120). Hence, Johnson and Christensen (2008:151) affirmed the explanation put forward by Muijs (2004). They described construct validity as relating a measuring instrument to a general theoretical framework in order to determine whether the instrument conforms to the concepts and theoretical assumptions that are employed.

To guard against construct validity, after drafting the measuring instruments they were given to colleagues, experienced researchers and to the supervisor to check the validity of the instruments before administering them. Therefore, the relevance of the questions to the respondents under study was assessed. By doing so, any ambiguities were revealed and this achieved the degree of precision necessary for the respondents to understand exactly what was asked.

3.7.1.3. Face validity

Face validity describes the degree to which the test appears to measure what it is supposed to measure (Vogt, 2007:120). This can be determined by asking individuals to cross check the items and decide whether the test is valid. Vogt (2007:123) pointed out the significance of having an instrument to have face validity; it brings about the cooperation and motivation of respondents; it reduces feelings of dissatisfaction among low scorers; it stimulates the interest of participants to complete the instruments. Pilot testing the questionnaire also aimed at checking the face validity.

3.7.2 Reliability of the instrument

McMillan and Schumacher explained instrument reliability as *the consistency of measurement, or the extent to which the scores are similar over different forms of the same instrument* (McMillan & Schumacher, 2010: 131). Cohen *et al*. (2000:117) were of the view that reliability deals with how accurate and precise the instrument is. In addition, Muijs (2004:71) explained reliability as the degree to which test scores are devoid of measurement errors. In other words, data collection is reliable if a researcher gets essentially the same data from different respondents during any measuring instance or that varied from time to time for a given unit of analysis measured twice or more by the same instrument (Robson, 2007:71). On the other hand, an instrument is valid if different researchers administered the same instrument and obtained the same results under similar conditions.

In contrast, Robson (2007:71) asserted that it is usually impossible to get the same result of a measurement when working with people. There is a possibility of measurement error. Therefore, to guard against reliability in this study, the instruments were piloted, then revised, before given to experts for the final checking.

3.8 PILOT STUDY

Pilot test is an introductory test of a questionnaire (Johnson & Christensen, 2004:177). Research instruments are pilot tested to increase validity and reliability (Cohen *et al*., 2000:260). Hence, researchers pilot test the instruments for the following reasons (Cohen et al., 2000:260; McMillan & Schumacher, 2001:185, Wilson & Sapsford, 2006:103-104):

- To guard against validity and reliability;
- To eliminate difficulties in wording and biased items;
- To gain feedback on appropriateness of questions;
- To gain feedback on the layout of the questionnaire;
- To check the time it takes the respondents to complete the questions; and
- To check problems that have been experienced by respondents so that the researcher can remove any irrelevant items which do not yield usable information.

Two schools within Mthatha district were randomly chosen for the pilot testing. These schools were chosen because they have similar characteristics with the sampled schools in Mthatha. Simple random sampling method was employed to select five (5) learners from Grade 11 and five (5) learners from Grade 12 respectively from each school for the pilot study, together with two Physical Sciences teachers, one from each school. The questionnaires were administered to both Physical Sciences teachers and learners. Interviews were conducted after the questionnaires were completed.

The respondents were requested to comment on time taken to complete the questionnaire and whether there were questions that were not clear and difficult to answer. Questionnaires for Physical Sciences educators were completed within 30 minutes whilst that of science learners was completed within 20 minutes. When all respondents were requested to comment on the problem they encountered with the interview questions, they commented on the questions for the interview being too difficult to respond to.

To increase validity of the questionnaire and the interview questions, an analysis of the responses were made and it resulted in restructuring the questions. At the end, the interview questions were reworded and some questions discarded. The close-ended questionnaires were also restructured for clarity.

3.9 DATA COLLECTION

Data collection involves gathering of information concerned with the variables the researcher is interested in (McMillan & Schumacher, 2001:180). There are different methods used by educational researchers to collect data. These include tests, interviews, questionnaires, observation, and focus group (Johnson & Christensen, 2004:162). The choice of the type of data collecting method is based on its ability to answer the research question. Hence the researcher decided on the questionnaire and interview as the main source of data collection techniques, since it is generally accepted and recommended that researchers should not only rely on a single strategy and source of data collection method (Gay *et al*. 2006:446).

With the letter from the Department of Education granting the researcher permission to conduct the study, the researcher visited each of the sampled schools in June 2014, introduced herself to the principals of the schools, and explained the purpose of her study. Consequently, the researcher was introduced to the Physical Sciences teachers and learners. The necessary arrangements were made with the schools and letters of consent and assent issued out to the principals, Physical Sciences teachers, and Physical Sciences learners to be handed over to their parents. The researcher was told to come back in July 2014, since the learners were busy writing June examinations.

The researcher visited the schools again in August, after receiving ethical clearance from her university. The researcher used this second time visit for self-administering and completion of questionnaires and conducting interviews, as Robson (2007:43) strongly warns that many surveys suffer from poor responses if questionnaires are not self-administered.

Therefore, to obtain a 100 % response rate, which Gay *et al.* (2006:171) recommended as a very excellent response rate, the questionnaires were self-administered to the respondents. Questionnaires were collected immediately after completion, from each of the schools visited. The administering of the questionnaire by the researcher gave her a 100 % response rate. Gay *et al*. (2006:170) indicated that, the higher the percentage of returned questions, the better the data.

Interviews were conducted 30 minutes after the completion of the questionnaire in each of the sampled schools. The interview gave the researcher an opportunity to further elaborate on the purpose of the study and to establish rapport between the interviewer and the interviewee. In addition, it also gave the researcher a chance to judge the seriousness with which the respondents took the whole exercise, which was also a useful basis in the interpretation of results.

3.10 DATA ANALYSIS

Gay *et al*. (2006:5) described data analysis as a systematic organisation and synthesis of data that involves application of one or more statistical techniques. Data were analysed based on the responses from respondents. One hundred (100) questionnaires from Physical Sciences learners and teachers were completed and collected, together with the responses from the interview. The researcher examined each of the response patterns and data were analysed based on the responses given by respondents (Gay *et al*. 2006:172).

The data were analysed statistically using descriptive statistics. Descriptive statistics were used to summarise, organise and reduce large numbers of observations or make sense of a particular data (Johnson & Christensen, 2004:177).

3.11 ETHICAL CONSIDERATIONS

According to McMillan and Schumacher (2001:196), the term ethics refers to a system of moral principles that people use to decide the rightness or the wrongness of certain actions and to the goodness or badness of the motives and ends of such actions. In addition, Johnson & Christensen (2008: 101,118-119) go further to identify the following ethical issues which researchers should take into accounts: informed consent, avoidance of harm, violation of privacy, anonymity and confidentiality, deceiving respondents and respect of human dignity of which encompass right for full disclosure which he reminds anyone who is involved in research to be aware of.

In this study, respondents were assured of anonymity and confidentiality. The purpose and the procedures of the study were explained to learners and educators involved before questionnaires were self-administered.

OFFICIAL PERMISSION: In this study, permission was acquired from the Eastern Cape Department of Education, Mthatha District Education office to conduct research in seven high schools by writing a letter (Appendix A) requesting the education office to allow for permission to conduct the study. Permission to conduct research was granted by the Department of Education (Appendix B). Letters of request to conduct the study in the various schools (Appendix C), together with the letter for permission to conduct research from the District Office were self-delivered to the principals of schools. Responses from the principals of the selected schools were positive.

INFORMED CONSENT FORM: According to Johnson & Christensen (2008:112), informed consent is the procedure in which individuals decide whether to participate in a study after being informed of the facts that would be likely to influence their decision. Informed consent forms were issued out to all the respondents.

RIGHT OF PARTICIPANTS: The respondents were told that their participation were voluntary and that they had the right to withdraw from the study at any time if they so wished.

CONFIDENTIALITY: It indicates the handling of information in a confidential manner. Cohen and Manion (1989: 24) viewed confidentiality, as a privacy, which refers to agreements between people that limit others' access to private information. All data obtained in this research were treated with confidentiality and were not divulged to anyone. The participants were assured that the collection of data from the interviews was only for academic purposes.

ANONYMITY: To ensure anonymity the respondents were told not to write their names on the questionnaires. Information given anonymously ensured the privacy of the subjects. It is often necessary to identify respondents, so that reminders could be sent to them to respond to the questions, or followed up interviews could be conducted with certain respondents (Cohen & Manion 1989).

3.12 SUMMARY

The chapter focused on research design and methodology used in this study. Non- experimental quantitative survey studies of seven high schools in Mthatha, with science laboratories or without science laboratories were employed in this study. The chapter discussed data collection instruments, detailed strategies for the data collection process, reliability, and validity of the instruments. The chapter further covered the pilot study, which was carried out in two schools, the permission granted for the research, and ethical measures that were adhered to in the study.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION, AND INTERPRETATION

4.1 INTRODUCTION

The main objective of this study was to understand the extent to which school science laboratories and science resource centres have contributed to the improvement of the teaching of science subjects with particular reference to Physical Sciences. Hence, this chapter concentrates on analysis, presentation, and interpretation of data. It presents the views and opinions of respondents regarding the use of science resource centres and laboratories to improve performance of learners in Physical Sciences.

The views and opinions of respondents, as they are reflected in answers from the two questionnaires and the semi-structured interview that directed the study, were analysed, organised, interpreted, and presented.

4.1.1 Procedure for Data Analysis, presentation and interpretation

Questionnaire A, was answered by Physical Sciences teachers and questionnaire B, was answered by Grade 11 and Grade 12 Physical Sciences learners. Hence, data analysis, presentation, and interpretation were done according to the views and opinions of both science teachers and learners. The responses were analysed statistically and results were presented as bar graphs, pie charts, and tables. The semi-structured interview was directed to school principals, Physical Sciences teachers and learners. Participants' responses were coded and transcribed into themes, with the findings interpreted with the literature.

4.2 DATA ANALYSIS, PRESENTATION, AND INTERPRETATION OF QUESTIONNAIRE A

The questionnaire A was designed to elicit information on science teachers' views and opinions related to the use of science laboratory and resources centres to improve the performance of learners in Physical Sciences. The statistical information presented and interpreted in this section is from seven teachers teaching Physical Sciences in both private and public high schools in Mthatha.

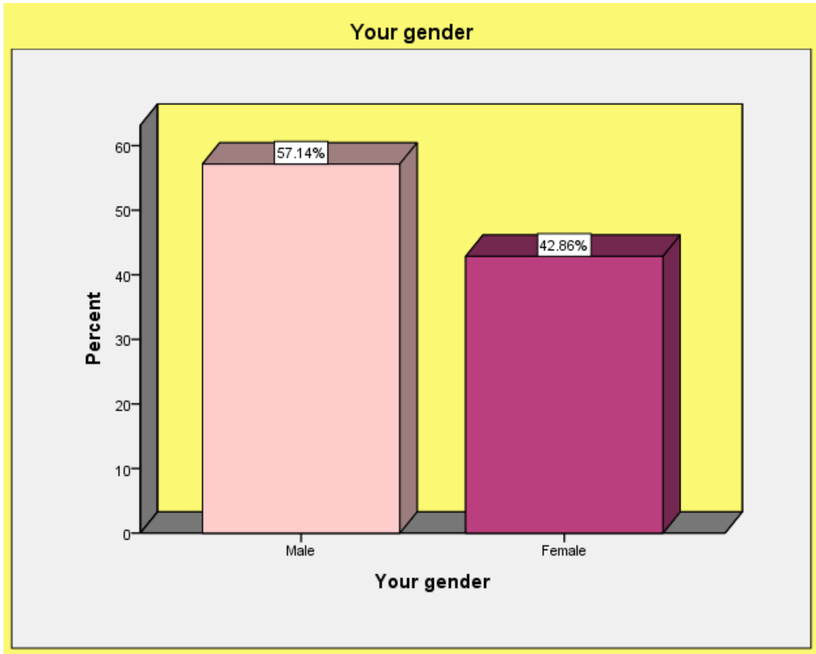
4.2.1 Biographical information of science teachers

This section presents biological information of science teachers in the sampled high schools. The information covers the following aspects;

- Teacher's gender
- Teacher's teaching experience
- Teacher's qualification in science at high school
- Highest qualification in science
- Major subjects studied during training as a teacher

The graph (Figure 4.1) below provides information on the gender of teachers who participated in the study.

Figure 4.1: Gender of science teachers



The graph in Figure 4.1 indicates that, 4 out of 7 were male respondents. The analysis further revealed that the females were 3 out of 7 of the total response. Literature affirmed this finding which revealed that, the science-oriented careers are male dominated (Pop *et al*. 2010:133).

The graph in the figure below provides information on the distribution of teachers in terms of their teaching experiences in teaching Physical Sciences.

Figure 4.2: Teaching experience of teachers

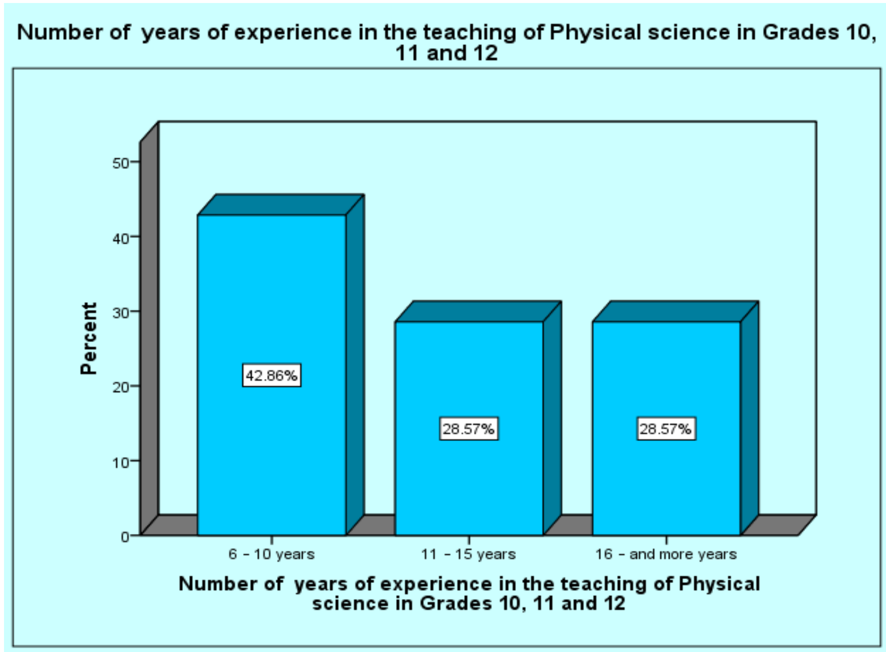
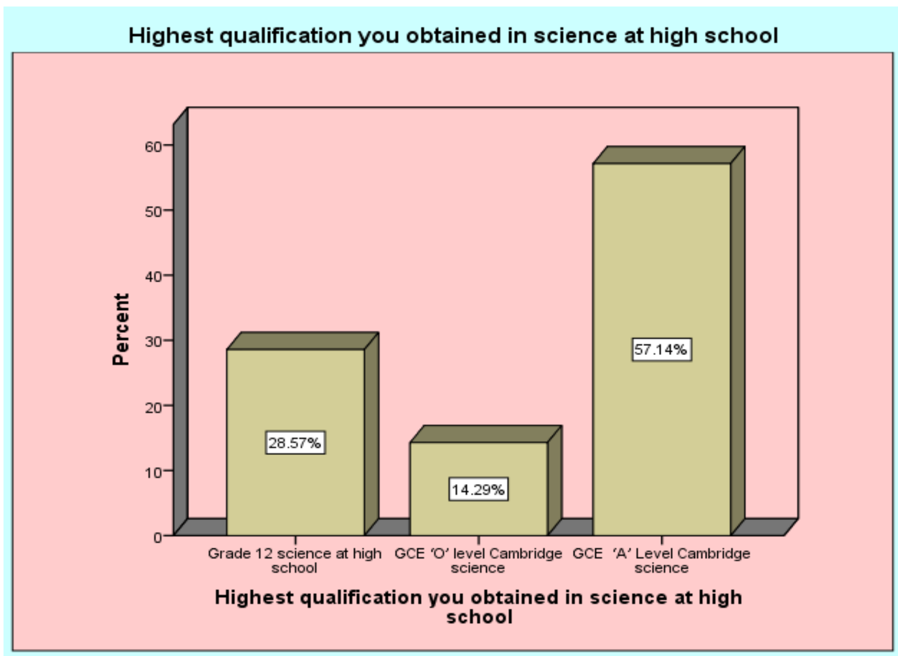


Figure 4.2 above indicates the results of distribution of teachers in terms of their experience in teaching Physical Sciences in Grade 10, 11 and 12. According to the analysis of the figure above, 3 out of 7 of the Physical Sciences teachers have six to ten years teaching experience, followed by teachers with eleven to fifteen years teaching experience(2 out of 7) with equal numbers as teachers with sixteen and more years of teaching experience (2 out of 7). This implies that, more teachers are experienced in teaching the subject. Research shows that experienced Physical Sciences teachers hold multiple perspectives on inquiry and inquiry teaching which is ideal for science teaching (Tseng *et al*., 2013).

The graph in the Figure 4.3 below provides information on the qualification obtained in Physical Sciences at high school by teachers who participated in the study.

According to the figure below, 4 out of 7 of the teachers had offered Physical Sciences at the GCE ‘A’ level Cambridge. This is followed by respondents who offered Physical Sciences at Grade 12 high school (2 out of 7). Further analysis indicates that only one of the respondents (1 out of 7) had GCE 'O' level Cambridge certificate in Science. This shows that all Physical Sciences teachers have the content base of the subject and a stronger background with the capability of teaching the subject in the high school. Research has shown that student achievement gains are much more influenced by teacher's qualification (Darling-Hammond & Youngs, 2002: 13) and a strong content base.

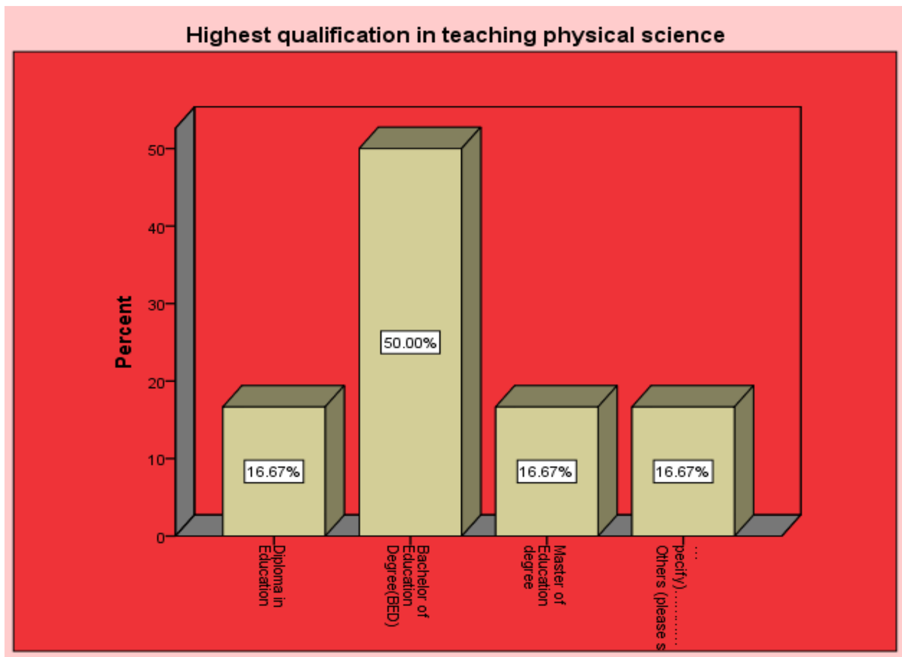
Figure 4.3: Qualification obtained in science at high school



The graph (Figure 4.4) below provides information on the highest qualification obtained by science teachers during their training as teachers. According to the analysis of the graph below relating to the highest qualification achieved by the teacher in teaching Physical Sciences, the results showed that 3 out of 7 agreed to have been awarded a Bachelor of Education Degree in Science and Mathematics.

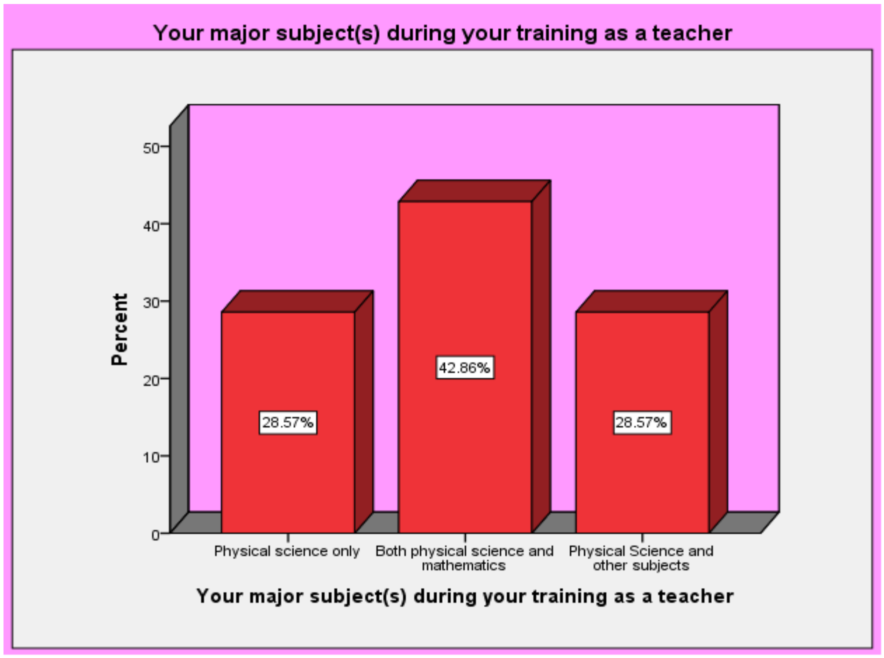
Further analysis indicated equal numbers of teachers with a Masters' Degree in Education (1 out of 7), which is followed by Diploma in Education (1 out of seven) and others (ACE, Teachers' Certificate) showing (1 out of 7). In addition, it was revealed that more teachers have University degree that qualifies them to teach Physical Sciences. In other words, all respondents have a certificate in Education and are qualified to teach. Hence, a study by Rice (2003) indicated that teachers who have earned advanced degrees have a positive influence on learners' achievement in Physical Sciences.

Figure 4.4: Highest qualification in teaching Physical Sciences



The graph below is a follow up to the analysis of the figure above. The graph illustrates the major subject(s) offered by the teachers during their training as teachers.

Figure 4.5: Major subjects offered during training as a teacher



According to the analysis of the Figure 4.5 above, 3 out of 7 of the Physical Sciences teachers majored in Mathematics and Physical Sciences, followed with equal percentages of teachers who majored in Physical Sciences only (2 out of 7) and Physical Sciences and other subject (2 out of 7). These results show that the respondents are all qualified to teach Physical Sciences in their schools. Literature shows that a teacher having a major in his/her teaching subject is the "most reliable predictor of students' achievement scores in mathematics and science" in the high school (Darling-Hammond, 2000).

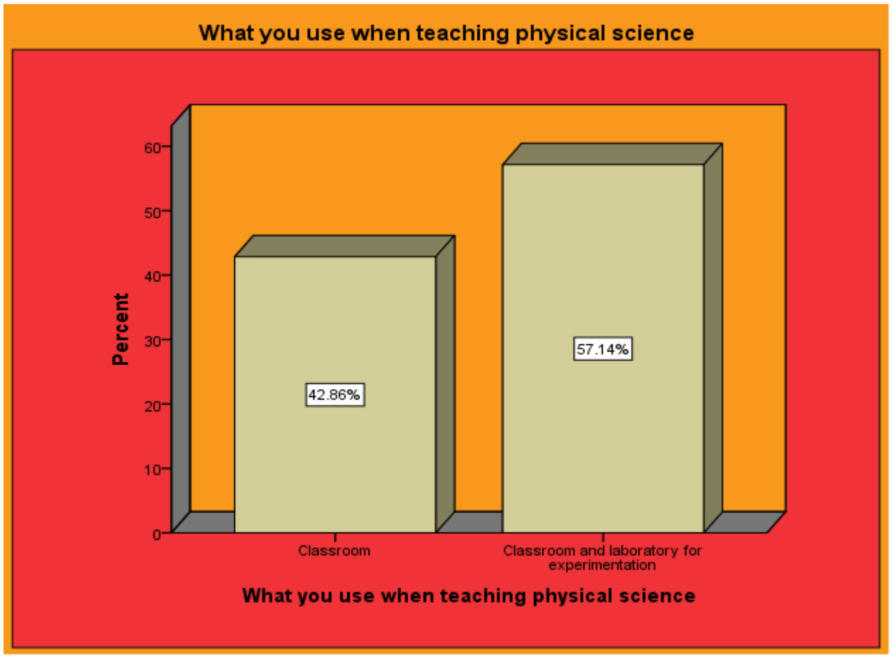
4.2.2: Resources available for science teaching

This section focused on the resources available for the Physical Sciences teacher to use to teach the subject. The following aspects were covered:

- Resources used in teaching;
- Accessibility of the resource; and
- Adequacy of resources.

The graph below (Figure 4.6) presents information on the physical resources available to the teacher when teaching Physical Sciences.

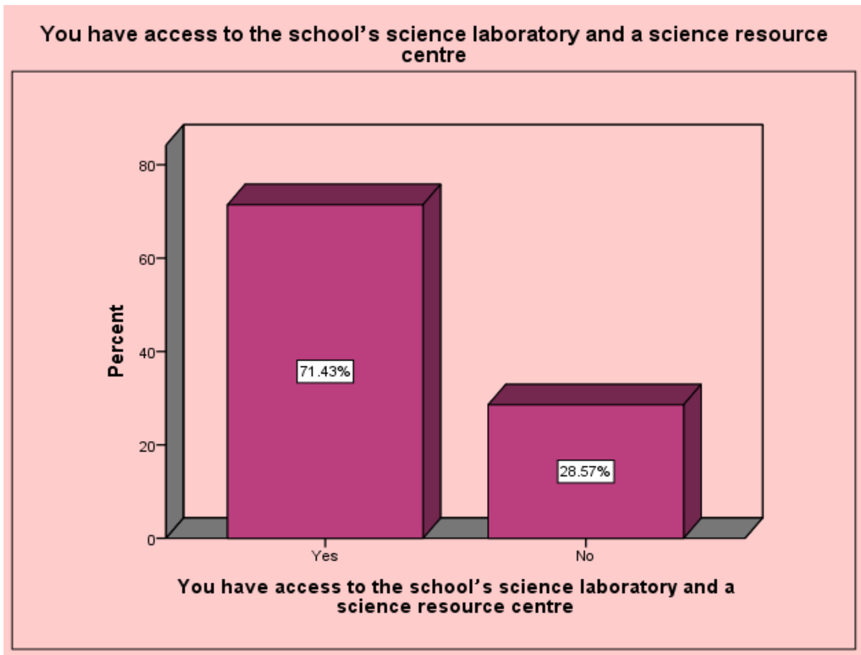
Figure 4.6: Resources available to the teacher when teaching Physical Sciences



According to the analysis of the figure above, majority of the teachers (4 out of 7) indicated that they use the classroom and the science laboratory for teaching and experimentation. This is followed by the teachers who indicated the use of the classroom only for the teaching of Physical Sciences (3 out of 7). From the graph above, 3 out of 7 of the teachers indicated the use of classroom only in teaching and learning of Physical Sciences. This implies, such schools lack laboratories and is therefore deprived of the benefits of using laboratories in science teaching. According to literature, laboratories have the potential to develop students' interest, abilities, and skills (Krajcik *et al*., 2001; Hofstein *et al*., 2005), and encourage them to learn Physical Sciences. Hence, schools without laboratories are deprived of these benefits.

The graph below (Figure 4.7) shows the distribution of responses from the science teachers with reference to the accessibility of the science laboratory in their schools and the resource centre. Analysis from the figure below shows that, 5 out of 7 teachers have access to the laboratory in their schools.

Figure 4.7: Access to the school's science laboratory and a science resource centre



Further analysis revealed that the teachers who do not have access to their schools' laboratory (2 out of 7), use the classroom for Physical Sciences activities. Having access to the laboratory means that learners would be able to learn Physical Sciences by doing (Hodson, 1992), that is; to be able to take part in hands-on activities that lead to the acquisition of scientific knowledge.

Follow up to the above analysis on the resource availability for Physical Sciences teaching, the Table 4.1 below focused on the adequacy of resources or materials and apparatus in the schools science departments. A rating scale of 1 to 5 which attributed to "*very poor*," "*poor*", "*average*," "*good*," and "*very good*" gave varied responses. To assist the researcher discuss the table, responses attributed to “*very poor and poor*” were collapsed together and considered as a negative response, thus indicating inadequate provision of resources. In addition, responses attributed to “*good and very good*” were collapsed together as positive, indicating adequate of resources. The responses were analysed in the table below.

From the analysis, majority of the respondents rated the following resources as adequate (good and very good) equipment for Physical Sciences (5 out of 7), stools/chairs for learners to sit on (5 out of 7), text books for reference (5 out of 7), CAPS document (5 out of 7) and learner support material (3 out of 7).

On the other hand, resources and materials that were rated as inadequate and in short supply(poor and very poor) included white boards(3 out of 7). Other resources that were of equal percentages included; computers (3 out of 7), scientific models (3 out of 7), wall chart (3 out of 7) and benches for learners to do experiments on (3 out of 7).

Table 4.1: Availability of materials, apparatus, and equipment in the laboratory

TABLE 4.1: EDUCATORS RESPONSES ON AVAILABILITY OF RESOURCES							
AVAILABLE RESOURCES	n	RATING OF AVAILABLE RESOURCES ON A SCALE OF 1 TO 5					
	%	VERY POOR	POOR	AVERAGE	GOOD	VERY GOOD	TOTAL
Reagent and apparatus for chemistry practicals	n	0	1	4	1	1	7
	%	0	14.3	57.1	14.3	14.3	100
Equipment for Physics practicals	n	0	1	1	5	0	7
	%	0	14.3	14.3	71.4	0	100
Stools/chairs for science learners to sit	n	0	0	2	4	1	7
	%	0	0	28.6	57.1	14.3	100
Benches for learners to do experiment	n	2	1	1	2	1	7
	%	28.6	14.3	14.3	28.6	14.3	100
science textbook for reference	n	1	0	1	3	2	7
	%	14.3	0	14.3	42.9	28.6	100
Whiteboards	n	1	2	2	1	1	7
	%	14.3	28.6	28.6	14.3	14.3	100
Computers	n	3	0	1	1	2	7
	%	42.8	0	14.3	14.3	28.6	100
Data projectors	n	2	0	3	2	0	7
	%	28.6	0	42.9	28.6	0	100
Scientific models	n	0	3	1	2	1	7
	%	0	42.8	14.3	28.6	14.3	100
Scientific wall chart	n	1	2	1	3	0	7
	%	14.3	28.6	14.3	42.8	0	100
CAPS documents	n	1	0	1	2	3	7
	%	14.3	0	14.3	28.6	42.8	100
Learner support material	n	1	0	3	2	1	7
	%	14.3	0	42.8	28.6	14.3	100

Furthermore, two other resources were indicated as average and received higher percentage ratings. These were reagent and apparatus for Chemistry practicals (4 out of 7) and data projectors (3 out of 7).These findings suggest that most schools have adequate resources for Physical Sciences teaching. Hence, Hallack emphasised that when resources are available, relevant, and adequate, they improve the academic achievement of learners in Physical Sciences (Hallack, 1990 as cited by Adeogun, 2008: 145).

4.2.3 Knowledge of content of subject matter

This section focused on assessing the knowledge content of teachers in the teaching of Physical Sciences. The section was taken from section C of the questionnaire and includes the following:

- Aspect of Physical Sciences the teacher finds difficult to teach;
- knowledge content of the subject; and
- Knowledge of subject matter.

Data were presented and analysed in graphs and in a table.

According to the graph below, majority of the respondents (71.4%, n=5) expressed their views by indicating that they are comfortable with all aspects of Physical Sciences and do not have any problem teaching the subject. Further analysis revealed only two teachers (28.9%, n=2) indicated having difficulty teaching the Physics part of Physical Sciences. This findings correlate with Figure 4.5 which affirmed Physical Sciences as the major subject teachers offered during training. Hence, research indicated that the importance of subject knowledge of the teacher is the most notable in the fields of Physical Sciences (Ellen, 2007).

Figure 4.8: Aspect of physical science you find difficult to teach

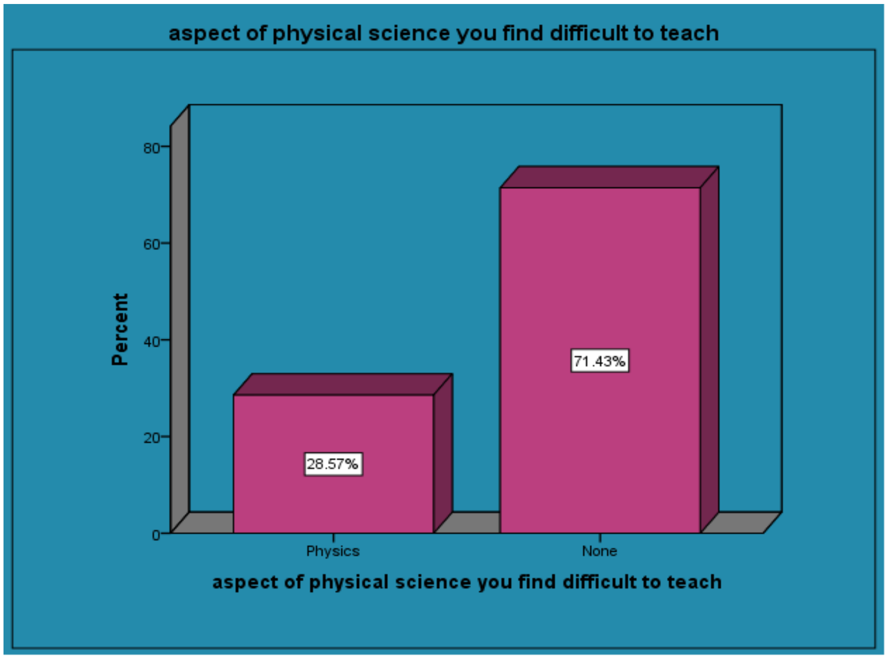


Table 4.2 below serves as a continuation to the discussion above which focused on the aspect of science the teacher finds difficult to teach. The table therefore, attempted to verify the knowledge content of subject matter from the respondents since some respondents (2 out of 7) found Physics part of Physical Sciences to be difficult.

This shows that Physical Sciences teachers may still have problem with the content matter and may not be able to impact knowledge to their learners. The responses were rated using a Likert scale of 1 to 5, measuring attributes such as; "*very poor,*" "*poor,*" "*average,*" "*good*" *and* "*very good.*" The researcher grouped the negative responses of "*very poor* and *poor*" as unsatisfactory and the positive responses of "*good* and *very good*" as satisfactory.

Tables 4.2: Knowledge content of subject matter

TABLE 4.2: KNOWLEDGE OF SUBJECT MATTER								
KNOWLEDGE OF SUBJECT MATTER	n	KNOWLEDGE OF CONTENT MATTER RATING ON A SCALE OF 1 TO 5					
	%	VERY POOR	POOR	AVERAGE	GOOD	VERY GOOD	TOTAL
In-depth knowledge of content	n	0	0	1	3	3	7
	%	0	0	14.3	42.9	42.8	100
Ability to answer questions asked by learners	n	0	0	1	1	5	7
	%	0	0	14.3	14.3	71.4	100
Confident in handling all topics in Physical Sciences	n	0	0	1	2	4	7
	%	0	0	14.3	28.6	57.1	100
Knowledge of Curriculum terminologies	n	0	0	1	2	4	7
	%	0	0	14.3	28.6	57.1	100
Knowledge of CAPS principles and policies	n	0	0	2	2	3	7
	%	0	0	28.6	28.6	42.8	100

Surprisingly, it was worth noting that Physical Sciences teachers responded positively to all the statements in the table. The analysis shows that majority of respondents (6 out of 7) responded to having an in-depth knowledge of content of Physical Sciences. Majority (6 out of 7) again responded as having the ability to answer questions asked by learners. Respondents (6 out of 7) further indicated that they are confident in handling all topics in Physical Sciences which the researcher thinks it is contrary to the previous statement in Figure 4.8, where respondents(2 out of 7) noted having difficulty teaching the Physics part of Physical Sciences.

Therefore, literature indicated that teachers who have professional education training or pedagogy and greater academic ability tend to have students who perform better (Kosgei *et al*. 2013). In contrast, Physical Sciences teachers with limited conceptual knowledge have poor grasp of the subject and makes a range of factual errors in content and concepts during his/her lessons. Teachers' poor conceptual and content knowledge contributes to low levels of learner performance in science (DoE, 2005:6)

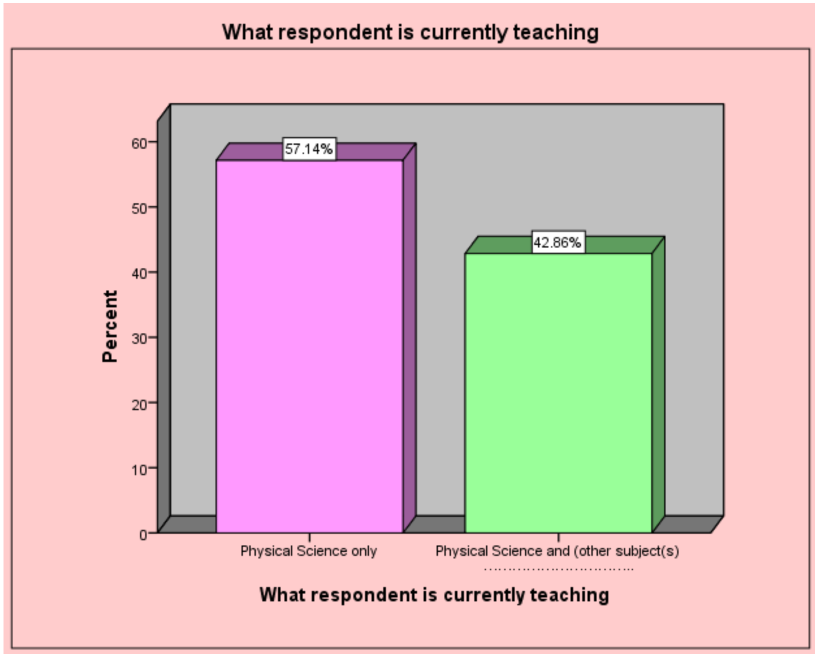
4.2.4 The teaching and learning of Physical Sciences

This section was taken from the section D of the questionnaire A and it focused on the teaching and learning of Physical Sciences. The section covered the following aspects:

- Whether the teacher is currently teaching science;
- Number of learners in science class and how the teacher copes with class size;
- Number of teachers' periods per week and how teacher copes;
- Teachers' teaching language;
- How the teacher rates learners' attitude towards the subject; and
- How often teacher uses teaching learning materials and organise extra lessons.

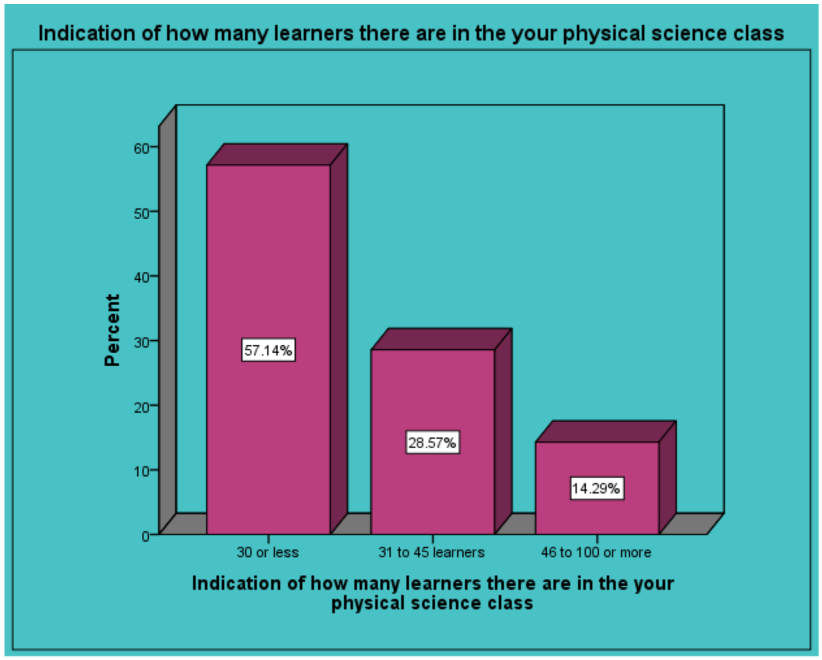
The graph (Figure 4.9) below provided information of the subject(s) the teacher is currently teaching. The analysis according to the graph above shows that majority of the respondents (4 out of 7) indicated that they teach Physical Sciences only in their schools. This was followed by the respondents (3 out of 7), who indicated that they teach Physical Sciences together with other subjects in their schools. Literature shows that teaching one subject will enable the teacher to concentrate his/her time and effort on that subject to enhance learners' understanding of the subject (Bigelow, 2010).

Figure 4.9: The subject(s) the teacher is currently teaching



The graph (Figure 4. 10) below presents the number of learners in respondents' class. According to the analysis performed on the graph below, majority of the respondents (4 out of 7) indicated they teach less than 30 learners in their Physical Science classes. This is followed by (2 out of 7), who indicated that they teach 31 to 45 learners in a class. The least among the percentages of responses was 1 out of 7. These respondents indicated teaching more than 45 learners in a class. From the analysis, it can be concluded that, teachers are not teaching larger classes and are therefore able to cope with their work. This small class size conforms to the teacher-learner ratio which was a strategic objective of the Department of Education to reduce the class size in schools. Hence, funding was secured in 2009 towards this imperative (DBE, 2009).

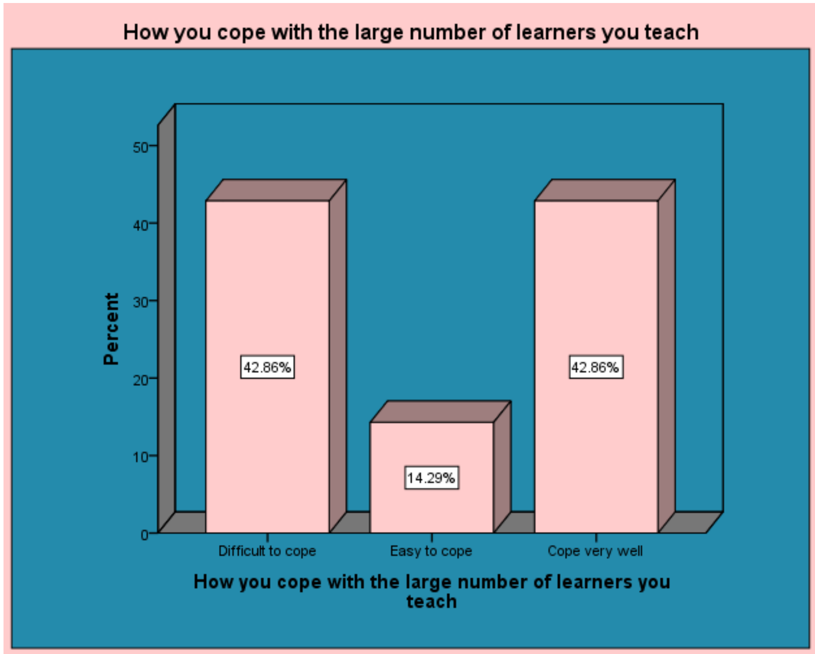
Figure 4.10: Number of learners in the science class



The graph below is a follow up to the analysis above. It was revealed that majority of respondents are not teaching large classes and has few learners that they can manage.

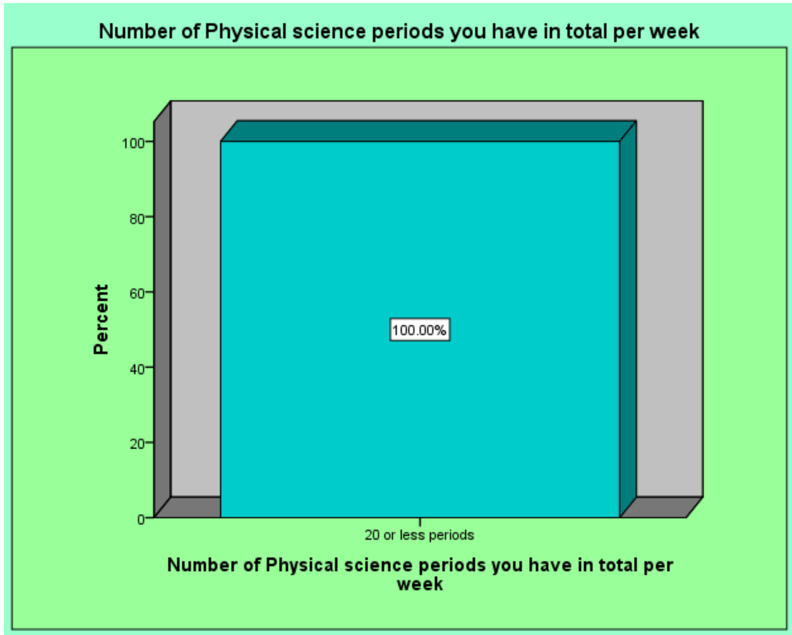
According to the analysis performed on the graph below, majority of respondents were under two response groups each with a response rating of 3 out of 7. The two responses were; “difficult to cope and cope very well.” The least among the percentages of responses was 1 out of 7. This indicated a response to “cope well.” The researcher collapsed the percentage positive responses and obtained a response rating of 4 out of 7. These were respondents who agreed on coping well with the number of learners in their classroom. Literature indicated that, smaller classes are associated with greater attempts to individualise instruction and better classroom climate (Smith & Glass, as cited by Gibbs & Jenkins, 1992).

Figure 4.11: Teachers' ability to cope with large class



The graph below illustrates the number of Physical Sciences periods a teacher has in total per week. According to the analysis of the graph below, all the teachers responded to less than 20 periods (7 out of 7) in total per week. This is relieving to teachers, because it indicates that teachers are not overloaded and might still have time with other school activities. Therefore, research has shown that teachers who are not overloaded are able to teach effectively, with their teaching characterised by student-centred activities associated with students being attentive, asking, and responding to questions and engaging in regular hands-on practical inquiry-based activities (Okedeyi *et al.*, 2013).

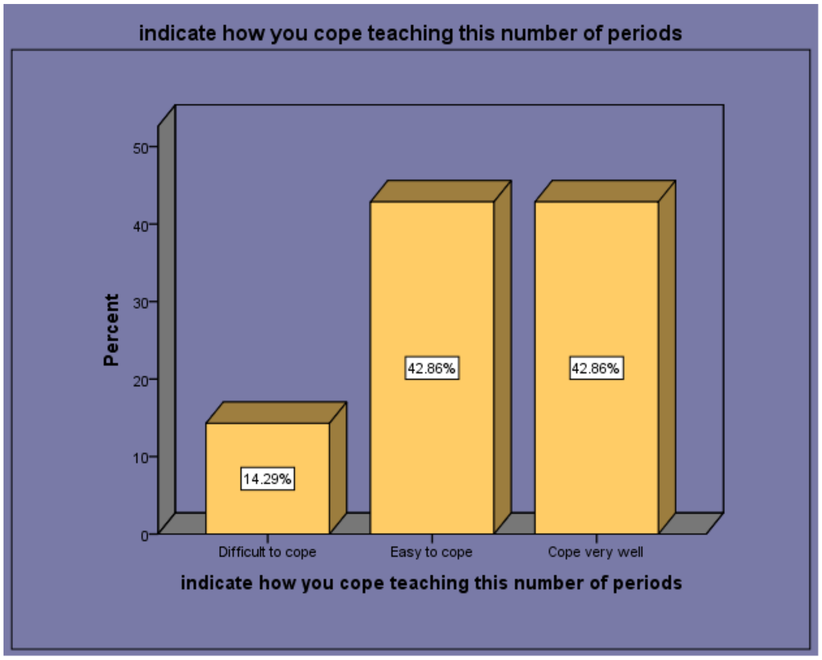
Figure 4.12: The number of periods the science teacher has per week



The graph below is a follow up to Figure 4.12 which presents views of teachers' ability to cope with more periods. According to the analysis performed on the graph below, majority of respondents were under two response groups each with a response rating of 3 out of 7. The two responses were; "easy to cope and very easy to cope". The least among the percentages of response was 1 out of 7, who indicated finding it difficult to cope in teaching more periods in a week.

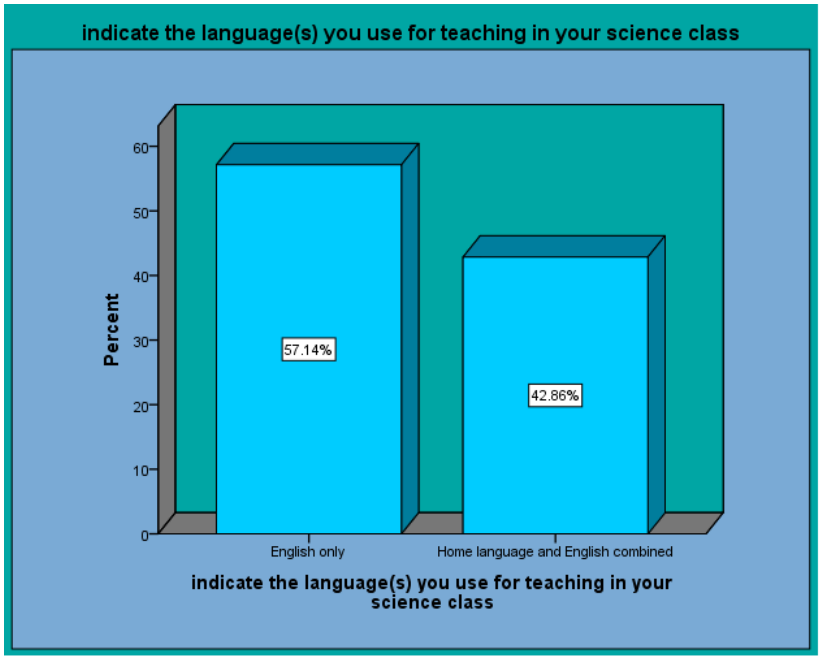
The researcher collapsed the percentages of positive responses of 'easy to cope' and 'very easy to cope' and obtained a response rating of 6 out of 7. These were respondents who agreed on "coping well and coping very well" with the number of periods they have in total per week. The researcher formed the opinion that since teachers have fewer periods in a week, they will have enough time to spend with their learners to improve their performance in Physical Sciences.

Figure 4.13: Ability of the teacher to cope with number of periods



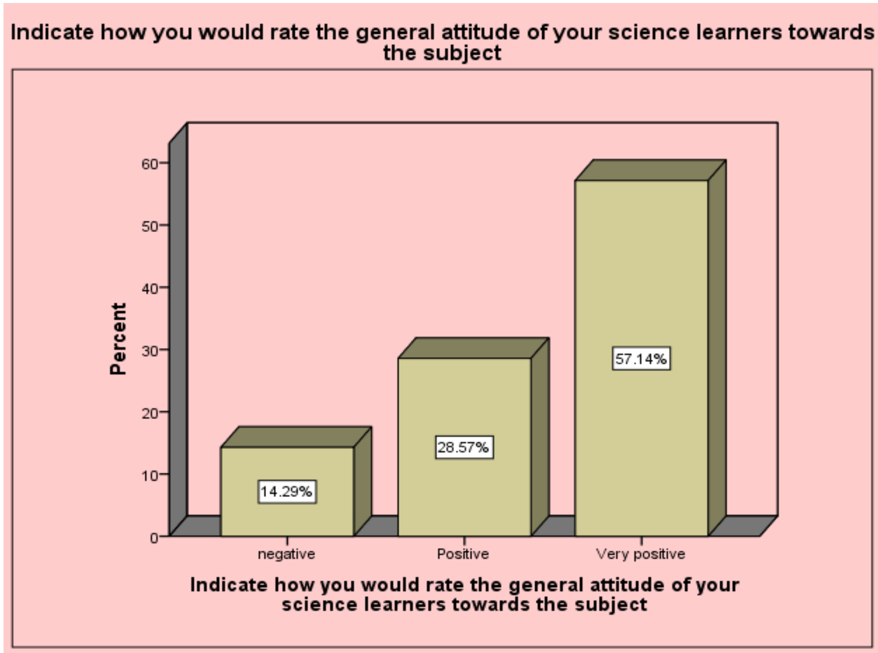
The figure below presents data on information about the teaching language of the teacher. According to the analysis of the graph below, majority of the respondents (4 out of 7) claimed that they preferred to use “English only” as the medium of instruction during Physical Sciences lessons. This was followed by 3 out of 7 of the Physical Sciences teachers who claimed that they preferred to use the learners’ home language and English combined as the medium of instruction during science lessons. The researcher observed a conditional problem posed by the wish of 3 out of 7 who claimed that a number of learners would prefer their home language to English as the medium of instruction for the Physical Sciences lessons. This creates a serious problem to the affected learners as they are disadvantaged as a result of their failure to understand English, which is the language of instruction even at higher levels of studies.

Figure 4.14: The language of instruction of the teacher during science lessons



Further to the above analysis, the figure below presented information on how teachers rate their learners' attitudes toward Physical Sciences. The results from Figure 4.15 show that the majority (4 out of 7) of the respondents rated the statements as "very positive." This rating was followed by 2 out of 7 respondents who rated the statement as positive. The lowest among the response percentages was 1 out of 7, who responded "negative" to the statement.

Figure 4.15: Teachers views of their learners' attitude towards Physical Sciences



Further analysis revealed that majority who rated the statement as very positive and positive which when the percentages were collapsed together gives a positive response percentage of 6 out of 7. These findings show that learners have a positive attitude towards Physical Sciences. These findings therefore correlate with literature, which revealed that attitudes influence behaviours and behaviours in turn influence conduct and performance. When learners are supported by their teachers and they have a positive relationships with their teachers, ultimately it promotes a sense of school belonging and encourages learners to actively participate cooperatively in laboratory activities (Hughes & Chen, 2011:278).

Table 4.3 below presented information on how often the teachers use resources in their lessons. Their responses were recorded using a measuring scale of 1 to 4, attributed to never, seldom, often and very often.

For ease of discussion of the table, all values attributed to "*never*" and "*seldom*" were collapsed together and considered unsatisfactory. The values attributed to "*often*" and "*very often*" were also grouped together and considered as satisfactory.

It was however encouraging and motivating to note that all the respondents sufficiently used resources in their lessons. They recorded their views as follows: use a variety of teaching materials in the lessons (6 out of 7); allow learners to discover the content by varying teaching methods (6 out of 7); able to capture learners' interest with the use of learning materials (7 out of 7) and finally make use of different learning activities (7 out of 7).

Table 4.3: Use of resources in Physical Sciences lessons

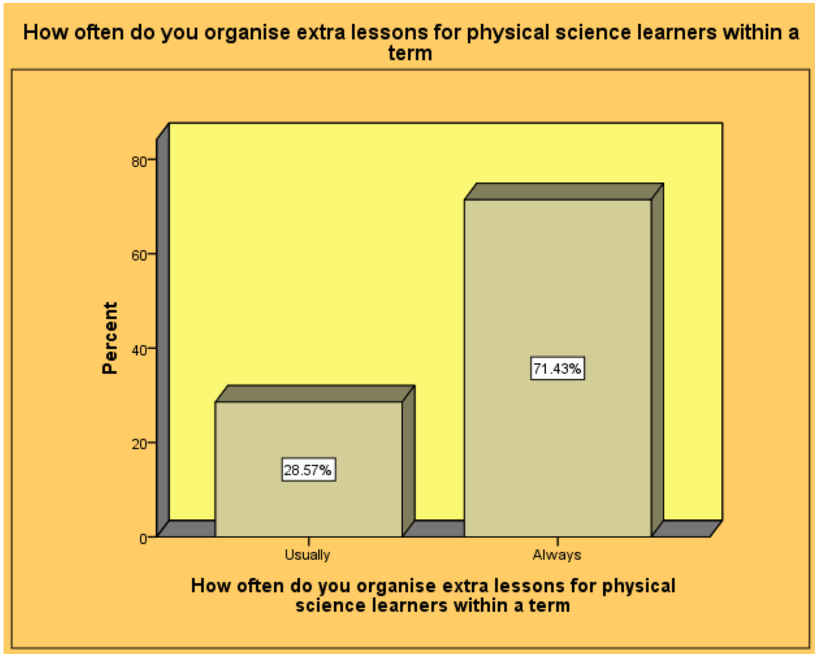
TABLE 4.2: TEACHERS' USE OF TEACHING/LEARNING MATERIALS						
TEACHERS' USE OF TEACHING/LEARNING MATERIALS	n	TEACHER'S USE OF TEACHING/LEARNING MATERIALS				
	%	NEVER	SELDOM	OFTEN	VERY OFTEN	TOTAL
Use a variety of teaching materials in lesson	n	0	1	3	3	7
	%	0	14.2	42.9	42.9	100
Allow learners to discover content by varying teaching materials	n	0	1	3	3	7
	%	0	14.2	42.9	42.9	100
Ability to capture learners interest by use of materials	n	0	0	4	3	7
	%	0	0	57.1	42.9	100
Make use of different learning activities	n	0	0	3	4	7
	%	0	0	42.9	57.1	100

This according to literature, learners are better able to grasp new pieces of information and discern patterns when presented with numerous, effective examples of materials in the science lesson (Rose & Meyer, 2002). In addition, the use of multiple representations as an inquiry tool in science teaching makes learners discover the content and capture their attention in the lesson (Kozma & Russell, 2005).

Below is a graph (figure 4.16) which is a follow up to the above table. The graph shows the willingness of the teacher to go extra mile in the teaching learning process by organising extra lessons for learners.

According to the analysis from the graph, majority of the respondents (5 out of 7) rated the statement as "*usually*." This rating was followed by (2 out of 7) of the respondents who rated the statement as "*always*." The researcher collapsed the two positive response percentages and got the following collapsed percentages obtaining response percentages of a (7 out of 7). This shows that teachers often organise extra lessons for their learners to improve performance. Literature indicates that engaging learners in extra work enhances their curiosity because they help learners to explore and ask questions. Learners' curiosity is at first immature, impulsive, spontaneous, easily stimulated by new things and new activities (Lindt, 2000:57).

Figure 4.16: Organisation of extra classes



4.2.5: Organisational skills of the teacher

The variables in this section were taken from section D of the questions and highlighted organisational skills of the Physical Sciences teacher. The table presented asked Physical Sciences teachers to assess their organisational skills in the teaching and learning process. A rating scale of 1 to 5 was used to record responses. For the sake of discussion of the table, statements attributed to "*very poor*" and "*poor"* were grouped together as unsatisfactory, and statement attributed to "*good*" and "*very good*" were grouped together and taken as satisfactory.

Table 4.4: Organisational skills of the science teacher

TABLE 4.4: ORGANISATIONAL SKILLS							
	n	ORGANISATIONAL SKILLS					
ORGANISATIONAL SKILLS	%	VERY POOR	POOR	AVERAGE	GOOD	VERY GOOD	TOTAL
Lesson preparation	n	0	0	0	2	5	7
	%	0	0	0	28.6	71.4	100
Ability to organise materials before lessons	n	0	0	1	2	4	7
	%	0	0	14.3	28.6	57.1	100
Classroom management during lesson	n	0	0	0	2	5	7
	%	0	0	0	28.6	71.4	100
Readily use of science resources in the lesson	n	0	0	1	5	1	7
	%	0	0	14.3	71.4	14.3	100
Recording and filing of class activities	n	0	0	2	4	1	7
	%	0	0	28.6	57.1	14.3	100
Assessment of learners strengths and weaknesses	n	0	0	0	5	2	7
	%	0	0	0	71.4	28.6	100
Assessment of own strengths and weaknesses	n	0	0	1	5	1	7
	%	0	0	14.3	71.4	14.3	100
Ability to maintain apparatus	n	0	0	1	1	5	7
	%	0	0	14.3	14.3	71.4	100

From the table, it was noted with satisfaction that positive responses were obtained from the following skills; lesson preparation (7 out of 7); ability to organise materials (6 out of 7); classroom management (7 out of 7); readily use of resources in lessons (6 out of 7); recording and filing of class activities (5 out of 7); assessment of learners strength and weaknesses (7 out of 7); assessment of teachers' own strength and weaknesses (6 out of 7) and ability to maintain apparatus (6 out of 7).

Further analysis revealed that few teachers rated their organisation skills with low percentage scores as average; skills such as recording and filing of class activities (2 out of 7), with equal percentage scores (1 out of 7) for skills such as ability to organise and ability to maintain apparatus. None of the respondents rated their organisational skills as unsatisfactory. Hence, research shows that giving learners authority over class activities (learner- centred) by allowing them to choose topics from the Physical Science content to investigate and using resources in teaching, will assist learners to link up the concept with their prior knowledge to enhance inquiry learning (Domin 1999: 545).

4.2.6 Teaching practical investigation and conducting experiment

This section focuses on the teaching of practical investigation and conducting an experiment in the science laboratory. A Likert scale with a rating of 1 to 5 was used to measure views and opinions of respondents. The analyses of responses were represented in a table below. For the discussion of the table, statements attributed to "*never*" and "*seldom*" were grouped together and considered as unsatisfactory whereas "*often*" and "*very often*" were grouped as satisfactory.

Further analysis of the table above shows that majority of the participants responded positively to the following statements: I teach important concepts before conducting experiments (4 out of 7); I provide learners with questions to investigate (6 out of 7) ; I design scientific investigation to guide activities (5 out of 7); I supply manuals to learners to follow during investigation (5 out of 7); I have difficulty in using some laboratory equipment (5 out of 7); I conduct experiments to verify fact (5 out of 7) and learners are guided by the teacher during practicals (5 out of 7). In addition, other respondents were of the view that they sometimes derive investigation activities from text books (4 out of 7) and allow learners to work without intervention (4 out of 7).

Table 4.5 Teaching practical investigation and conducting experiments

TABLE 4.5: OPINIONS ON TEACHING PRACTICAL INVESTIGATIONS AND CONDUCTING EXPERIMENT							
OPINIONS ON TEACHING PRACTICAL INVESTIGATION AND CONDUCTING EXPERIMENT	n	Opinions of teaching practical investigation and conduction experiment					
	%	NEVER	SELDOM	SOMETIMES	OFTEN	ALWAYS	TOTAL
I derive investigation activities from text books.	n	0	0	4	1	2	7
	%	0	0	57.1	14.3	28.6	100
I teach concepts before conducting scientific investigation.	n	1	1	1	3	1	7
	%	14.3	14.3	14.3	42.8	14.3	100
Learners suggest questions and problems for investigation.	n	2	1	2	1	1	7
	%	28.6	14.3	28.6	14.3	14.3	100
I provide learners with questions to investigate.	n	0	0	1	5	1	7
	%	0	0	14.3	71.4	14.3	100
I design scientific investigation to guide activities.	n	1	0	1	5	0	7
	%	14.3	0	14.3	71.4	0	100
Learners are allowed to work without intervention.	n	2	0	4	0	1	7
	%	28.6	0	57.1	0	14.3	100
I supply manuals to learners to follow during investigation.	n	2	0	0	3	2	7
	%	28.6	0	0	42.8	28.6	100
I have difficulty in using some laboratory equipment.	n	2	0	0	3	2	7
	%	28.6	0	0	42.8	28.6	100
I conduct experiments to verify fact.	n	1	0	1	2	3	7
	%	14.3	0	14.3	28.6	42.8	100
Learners are guided by the teacher during practicals.	n	0	0	2	1	4	7
	%	0	0	28.6	14.3	57.1	100

However, responses from few participants were unsatisfactory and rated the following statement: learners suggest questions for investigation activities (3 out of 7) as negative, stating the fact that learners are not allowed to suggest questions for investigative activities. Nevertheless, research has shown that practical investigations and experiments form an integral part of the formal assessment programme in the new curriculum (CAPS) which was implemented in all schools in South African in January, 2012 (DoE, 2011). Therefore, the interaction between teaching and learning approach, the teacher, and the learners engaged in laboratory activities should teach learners to develop academic skills in terms of content and also develop technical skills in handling equipment and making measurements (Millar, 2004:4). In addition, Wickman (2004:332) has shown that the sequence of the laboratory activities to be conducted by the learners is an important factor to determine what has to be learned in terms of content. This is because when activities are in a particular order, they lead to a particular results and this can be an indicator to the learners of what is important.

4.2.7 ICT use in the teaching and learning of science

This section requested respondents to indicate their views about the use of ICT in the resource centres and the laboratories in the teaching and learning of Physical Science. A five Likert rating scale attributed to: "*strongly disagree", "disagree*", "*uncertain*", "*agree*" and "*strongly agree*" was used to measure levels of agreement or disagreement, and responses presented in a table below.

For the purpose of discussion of the table, the percentages of positive responses of "agreed and strongly agreed" were grouped together as an agreement. Percentages of negative "responses of strongly disagreed and disagreed" were also grouped together as disagreement.

By analysing Table 4.6, it is worth noting that all the participants were in agreement to all the statements in the table. Percentages of respondents were as follows:

- I do use ICT (computer simulation and data logging) in teaching (4 out of 7);
- I have knowledge on the use of ICT in teaching (7 out of 7);
- ICT should always be used in teaching science (4 out of 7);
- use of ICT should be integrated into traditional normal teaching (5 out of 7);
- using ICT in teaching makes teaching easier(7 out of 7);
- ICT usage saves a lot of time in teaching(7 out of 7);
- ICT usage in teaching makes diagrams clearer(5 out of 7);
- using ICT in teaching captures attention(6 out of 7);
- ICT usage helps class control(6 out of 7);
- using ICT in teaching brings excitement to learners(7 out of 7);
- ICT usage makes it easier for learners to visualised(5 out of 7); and
- ICT usage makes imaginary concepts real (6 out of 7).

From the table, it is clear that teachers agreed to the fact that ICT usage in teaching can improve the teaching and learning of Physical Sciences. This is because the teachers responded positively to all the statements provided in section G of the questionnaire. These findings correlate with literature which revealed that ICT helps learners to become knowledgeable, reduces the amount of direct instruction given to them, and gives teachers an opportunity to help those learners with particular needs (Iding, Crosby & Speitel, 2002, Shamatha, Peressini & Meymaris, 2004, Romeo 2006).

Table 4.6: Teachers views about the use of ICT in the teaching and learning of science

TABLE 4.6 : ICT USE IN TEACHING AND LEARNING OF SCIENCE							
	n	ICT USE IN THE TEACHING /LEARNING PROCESS					
ICT USE IN THE TEACHING AND LEARNING PROCESS	%	STRONGLY DISAGREE	DISAGREE	UNCERTAIN	AGREE	STRONGLY AGREE	TOTAL
I do use ICT (simulation and data logging to teach science.	n	1	1	1	1	3	7
	%	14.3	14.3	14.3	14.3	42.8	100
I have knowledge on ICT use in teaching science.	n	0	0	0	4	3	7
	%	0	0	0	57.1	42.8	100
ICT should always be used in teaching science.	n	0	0	3	2	2	7
	%	0	0	42.8	28.6	28.6	100
ICT use should be integrated into traditional teaching methods.	n	0	0	2	1	4	7
	%	0	0	28.6	14.3	57.1	100
Using ICT in teaching makes teaching easier.	n	0	0	0	3	4	7
	%	0	0	0	42.9	57.1	100
ICT usage in teaching saves time.	n	0	0	0	3	4	7
	%	0	0	0	42.9	57.1	100
ICT usage in teaching makes diagrams clearer.	n	1	0	1	1	4	7
	%	14.3	0	14.3	14.3	57.1	100
ICT usage in teaching captures learners' attention.	n	0	0	1	2	4	7
	%	0	0	14.3	28.6	57.1	100
ICT usage in teaching controls the class.	n	0	0	1	4	2	7
	%	0	0	14.3	57.1	28.6	100
ICT usage in teaching brings excitement in learners.	n	0	0	0	5	2	7
	%	0	0	0	71.4	28.6	100
ICT usage in teaching helps learners to visualise lessons.	n	1	0	1	1	4	7
	%	14.3	0	14.3	14.3	57.1	100
ICT usage in teaching makes imaginary concepts real.	n	1	0	0	1	5	7
	%	14.3	0	0	14.3	71.4	100

4.2.8. Respondents' opinions about the teaching and learning of science

This section provides information relating to opinions of respondents about the teaching and learning of Physical Sciences in their schools. A rating scale of 1 to 5 was used to measure their level of agreement or disagreement to the statements given in section H of the questionnaire. Statements attributed to "*strongly disagree," "disagree," "uncertain", "agree"* and *"strongly agree"* were used to measure levels of agreement or disagreement. Responses were presented and analysed in the table below.

To assist the researcher discuss the table, positive responses ("agreed and strongly agreed") were grouped together and considered as "agreed". Negative responses ("disagreed or strongly disagreed") were grouped together and considered as "disagreed".

From the table 4.7, majority of respondents were in agreement to the following statements and responded positively towards them: I take responsibility if accident occurs (5 out of 7); I organised field trips for learners (3 out of 7); I give learners chance to reflect on their strength and weaknesses (5 out of 7); I vary my teaching methods(7 out of 7); I give home work (7 out of 7); my HOD listens to teachers' suggestions(4 out of 7) ; I am content with my work as a science teacher (7 out of 7) ; and CAPS has too much of paper work (5 out of 7).

Table 4.7: Respondents opinions about the teaching and learning of physical sciences

TABLE 4.7: OPINIONS OF RESPONDENTS							
	n	respondents opinions					
OPINIONS OF RESPONDENTS	%	STRONGLY DISAGREE	DISAGREE	UNCERTAIN	AGREE	STRONGLY AGREE	TOTAL
I teach science for exam purposes only.	n	3	1	1	2	0	7
	%	42.9	14.3	14.3	28.6	0	100
I do experiments in science even if it is dangerous.	n	3	1	2	0	1	7
	%	42.9	14.3	28.6	0	14.3	100
I do not give learners chance to perform certain experiments.	n	6	0	0	1	0	7
	%	85.7	0	0	14.3	0	100
I take responsibility if accidents occur.	n	0	2	0	2	3	7
	%	0	28.6	0	28.6	42.8	100
I organise educational field trips for my learners.	n	1	1	2	1	2	7
	%	14.3	14.3	28.6	14.3	28.6	100
I give learners chance to reflect on their strength and weaknesses.	n	0	0	2	3	2	7
	%	0	0	28.6	42.8	28.6	100
I vary my teaching methods in my lessons.	n	0	0	0	2	5	7
	%	0	0	0	28.6	71.4	100
I give out home work to my learners to reinforce the lesson.	n	0	0	0	3	4	7
	%	0	0	0	42.9	57.1	100
Time table permits me to spend more time with weaker learners.	n	3	1	1	2	0	7
	%	42.8	14.3	14.3	28.6	0	100
My HoD listens to suggestions from science teachers.	n	1	1	1	3	1	7
	%	14.3	14.3	14.3	42.8	14.3	7
The way this school is run makes it difficult for teachers to perform their duties.	n	4	0	1	1	1	7
	%	57.1	0	14.3	14.3	14.3	100
I am content with my work as a science teacher.	n	0	0	0	1	6	7
	%	0	0	0	14.3	85.7	100
CAPS has too much of paper work.	n	0	1	1	3	2	7
	%	0	14.3	14.3	42.8	28.6	100

Further analysis revealed that, most respondents disagreed to the following statement: I teach for examination purposes only (4 out of 7); I do experiment even if it is dangerous to learners(4 out of 7); I do not give learners chance to perform certain experiments(6 out of 7); time table permits me to spend more time with weaker learners(4 out of 7); and the way this school is run makes it difficult for teachers to perform their duties (4 out 7).

Hence, the findings revealed that teachers use varying teaching methodology to enhance learners understanding. Literature has shown that the science laboratory should not only be seen as an organisational setting where scientific concepts can be verified and demonstrated (Tamir *et al*. 1992) but also as a place where learners' process skills can be developed. Hence, learners use their previous experience, knowledge, and skills to perform science processes successfully during experimental inquiry (German & Aram 1996:777), and when learners are faced with challenging problems, and been given the opportunity, they are able to carry out an experiment to solve the problem. By so doing, they acquire knowledge and learn best (Greenwald, 2000:28).

4.3 Data analysis and interpretation of questionnaire B

The questionnaire B was designed to obtain information on high school learners' views and opinions related to the use of science laboratory and resources centres to improve the performance of learners in science. The statistical information presented and interpreted in this section was responses from 93 learners from private and public high schools in Mthatha.

4.3.1 Biographical information of science learners

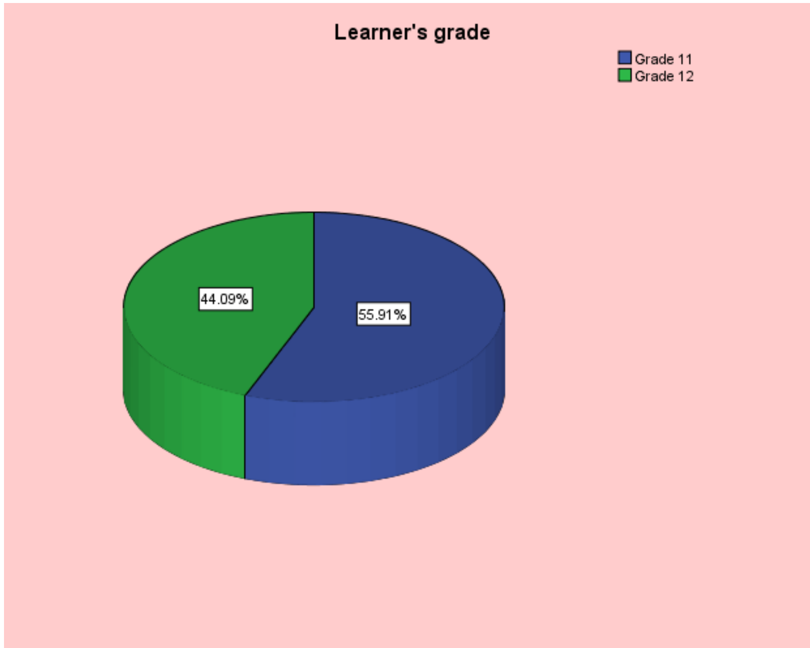
The biographical information of science learner obtained from this study consists of the following aspects:

- Learners schools and Grades;
- Learners' age and gender;
- Learners' ownership of calculator; and
- How often learners absent themselves from school.

All the seven participating schools were equally represented in the final sample. This is because, the researcher decided to give equal weight to all the sampled schools. The researcher due to research ethics decided to hide the anonymity of the schools and chose to label them using the English alphabetical capital letters, namely; A, B, C, D, E, F, G.

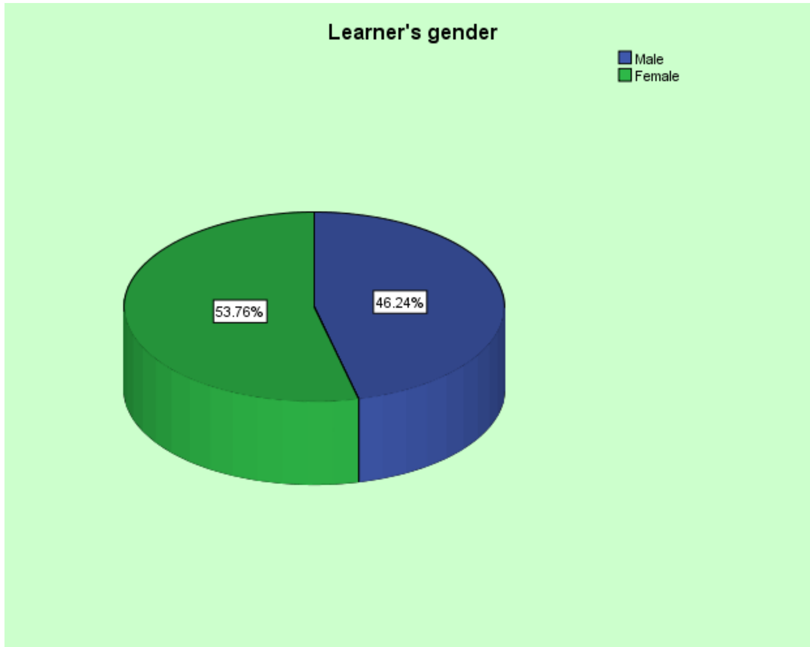
The figure 4.17 below provided information on respondents' Grade levels. Analysis on the figure shows that majority of the respondents (55.9%, n=52) were drawn from Grade 11. Those drawn from Grade 12 formed 44.0% (n=41) of the total sample size. This means that more respondents were grade 11 learners as compared to grade 12 learners.

Figure 4.17: Science learners in each Grade



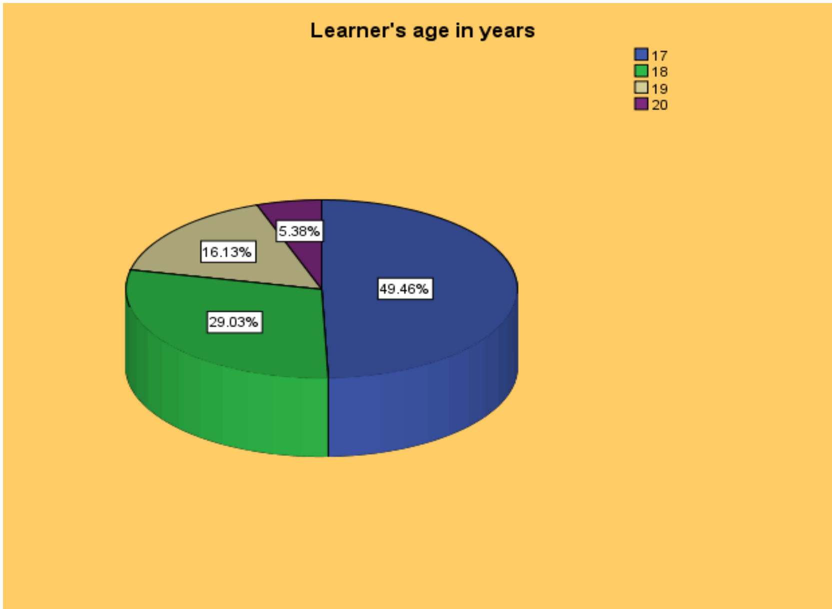
Below is a graph (figure 4.18) indicating the gender of Physical Sciences learners. The analysis revealed that the males formed 46.2 %(n=43) and the females form 53.8% (n=50) of the total respondents. More females than males suggested that the former were planning to take up careers in the science oriented fields since according to literature, the science classes are male dominated (Unisa, 2010:1).

Figure 4.18: Gender of respondents



According to the analysis on the figure below, the majority (49.5%, n=45) of respondents were learners aged 17 years. The second group in order of magnitude was for those (29%, n=27) aged 18 years. Those aged 19 years formed 16.1% (n=15).The least among the age percentages was the group aged 20 years which formed 6.5% (n=6). When the researcher collapsed the percentages for the two smallest ages of 17 and 18 years, the collapsed total percentage was 78.5%. This formed a total majority collapsed percentage response according to age in years. This researcher observed that grade 11 and 12 learners are fairly mature people with the smallest age being 17 years.

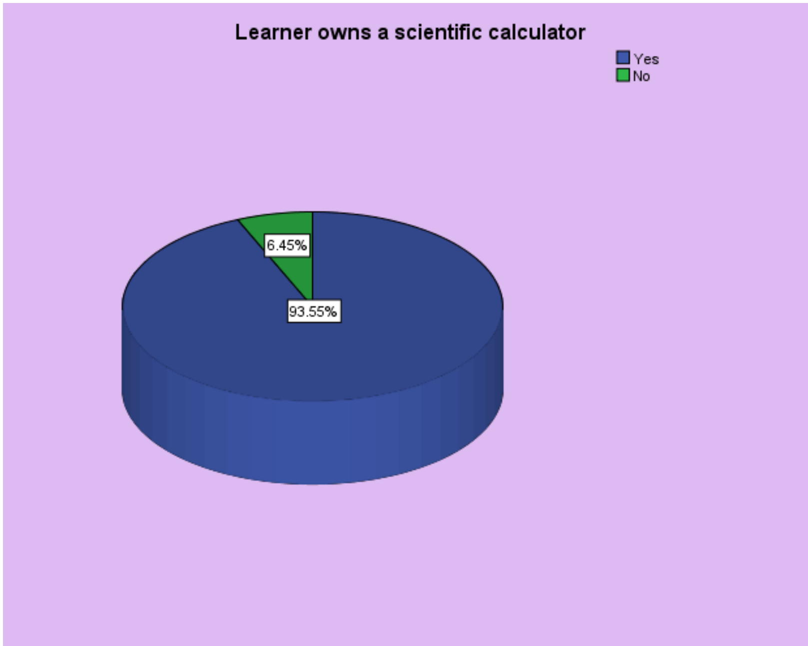
Figure 4.19: Learners age in years



The findings therefore suggested that, some learners might have started schooling too late or might have repeated a Grade.

Moving on to how learners learn science, the graph below indicates the number of respondents who owns a calculator. It was encouraging that learners are able to practice science on their own if they have all stationeries and resources required for practice.

Figure 4.20: Learners ownership of a calculator

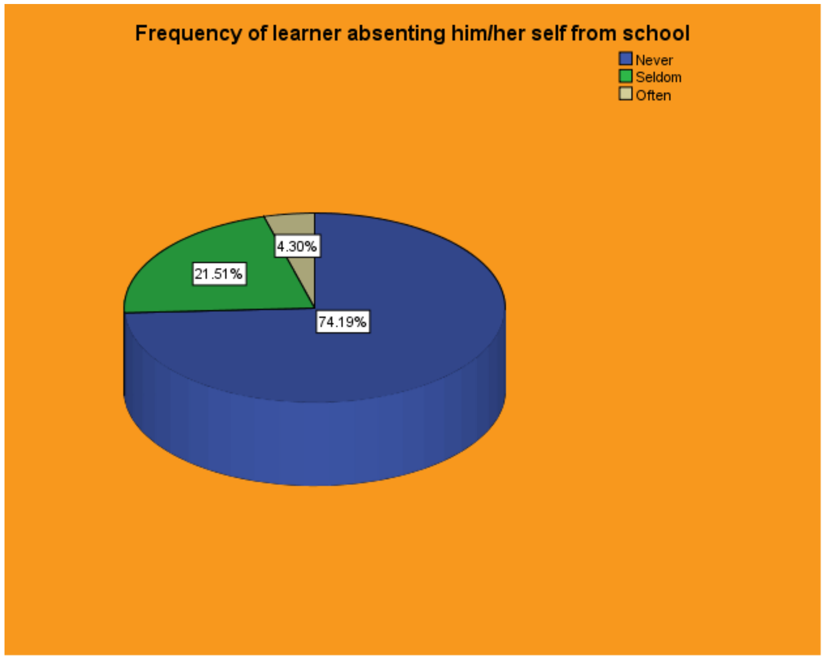


The analysis on the figure above relating to the ownership of calculators by Grade 11 and 12 learners showed that the majority (93.5%, n=87) agreed to owning a calculator. A negligible 6.5% (n=6) do not own calculators. The researcher interpreted this to be a good sign of both parental and learner responsibility for providing calculators to close to 94% of the learners. The researcher found this to be a step forward as it makes studying Physical Science very easy for learners. In fact, the availability of calculators to learners improves learner performance in all subjects which require the use of calculators.

The graph (figure 4.21) below presented information on the number of times learners absent themselves from school.

From the figure below, majority of the learners (74.2%, n=69) "never absent" themselves from school. This class of learners was followed by those (21.5%, n=20) who "seldom" absent themselves. The least among the response percentages to statement is 4.3 % (n=4) which represented those who "often" absent themselves from school.

Figure 4.21: Frequency of learners absenting themselves from school



The establishment that the majority of learners never absent themselves from school was an encouraging finding by this research in the sense that the researcher was convinced that the performance of the learners was promising as most of them attend classes regularly. The other noticeable issue concerns the good management of the schools in question.

4.3.2 The teaching and learning process

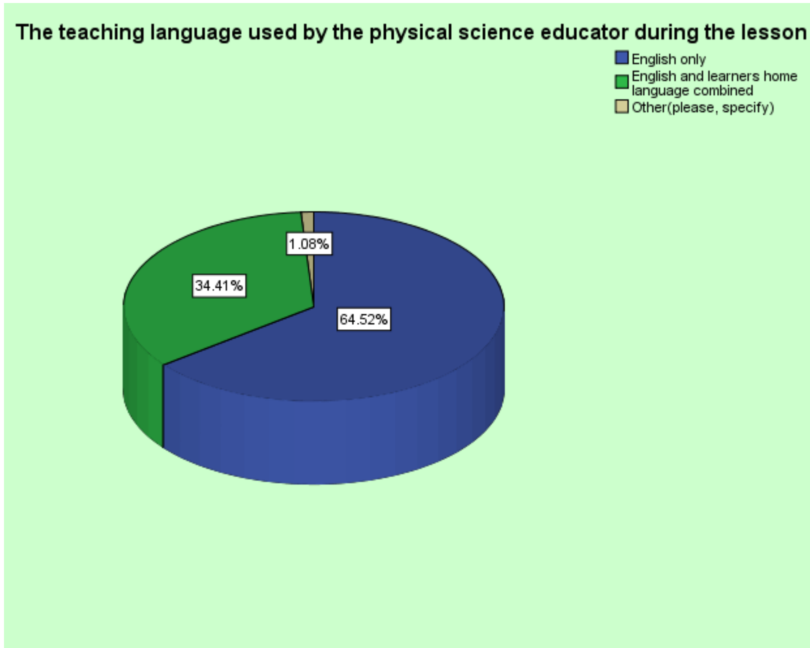
This section focuses on the views and opinions of learners in the teaching and learning process. Aspects such as:

- The teaching language of their teachers;
- Learners' understanding of the teaching language
- Language learners prefer; and
- Difficulties learners experience with English
- The traits exhibited by their science teachers.

Below is a graph (figure 4.22) indicating the teaching language of the science teacher during science lessons. The analysis with respect to the figure below shows that the majority (64.5%, n=60) of the respondents used English only as the teaching language for their Grade 11 and Grade 12 learners. This group was followed by 34.4%(n=32) who used English and learners' home language combined to teach their Grade 11 and Grade 12 learners during Physical Science classes. The least among type of language used percentages is 1.1 % (n=1) which was the case where response was different.

From the findings, the researcher makes two serious observations which could be stated as follows: That though the majority used English only as the Physical Science teaching/learning language, there are many (totalling 35.5%) who do not benefit from the same facility. This refers to those who mix English and other home languages during lessons. According to, Needham and Hill (1987: 13), learners are required to develop their English language skills in the context of content area instruction to assist them to master science content.

Figure 4.22: The teaching language used by the science teacher during lesson

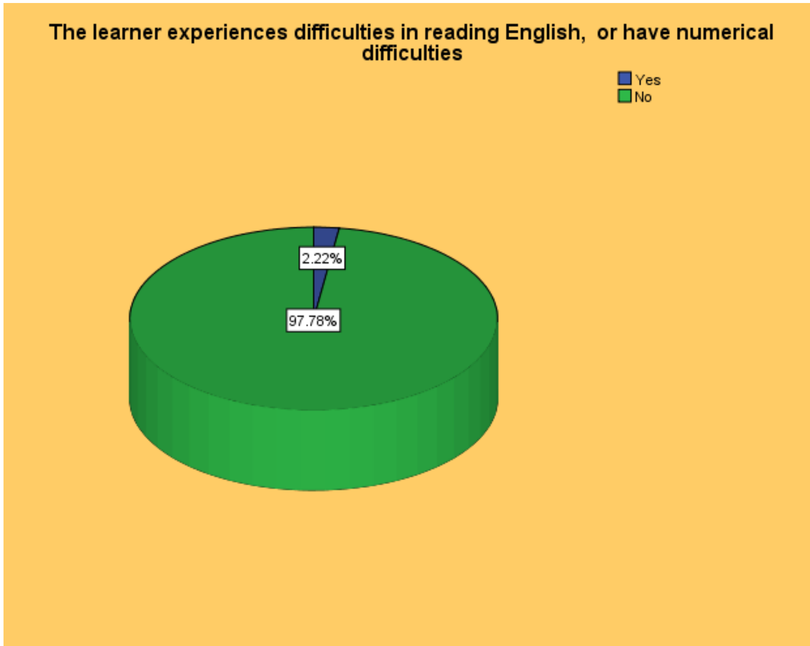


Hence, this sends a negative signal of the learning abilities of a significant fraction of the response. The researcher, therefore, being a Physical Sciences educator wishes to recommend a situation where there is uniformity in the learning/teaching approach for Physical Sciences educators.

Therefore, there is the need for the system to correlate this statement and the expected understanding of the subject matter.

The graph in Figure 4.23 presented data on the difficulties experienced by learners in reading English, writing English and with numbers.

Figure 4.23: Difficulty experienced by learners in reading English or have numerical difficulties

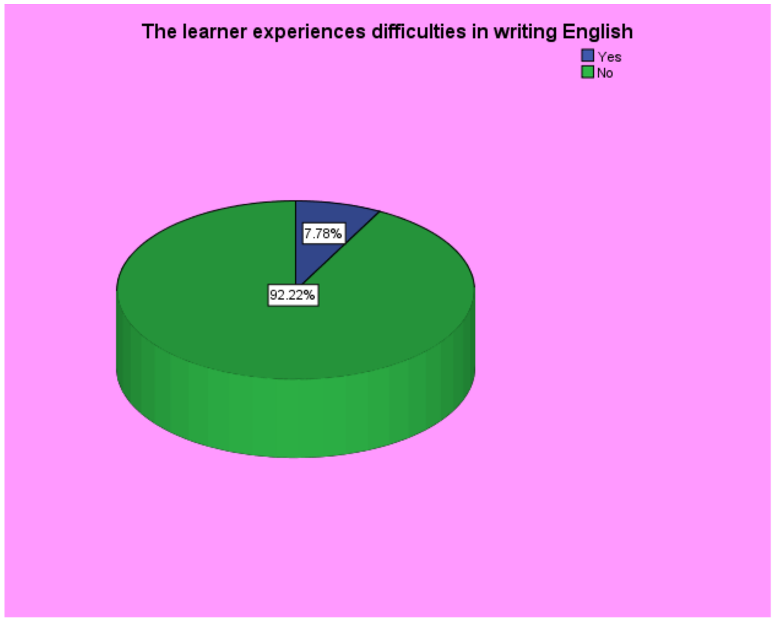


According to the analysis on the figure above, majority of the respondents (97.8%, n=91) never had problems with reading English nor do they have any numerical difficulties. A negligible percentage of (2.2%, n=2) accepted having difficulties with reading English as well as encountering difficulties with numerical calculations. This is a good result given that most of the learners in Mthatha have serious problems in Physical Sciences subjects.

This has been the experience for a long time due to lack of sufficient subject reading materials and lack of exposure to scientific programmes. In addition, the reader must be informed that this is a previously disadvantaged province where learners, on many occasions fall short of food, clothing, and even writing materials. Any of these parameters could contribute to poor performance. The researcher noted further that the fact that the majority of learners claimed they do not have difficulties in reading English nor having numerical difficulties does not mean they perform well.

Figure 4.24 is a follow up to the analysis above. The graph presented data on the difficulties experience by learners in writing English.

Figure 4.24: **Difficulty experienced by the learner in writing English**

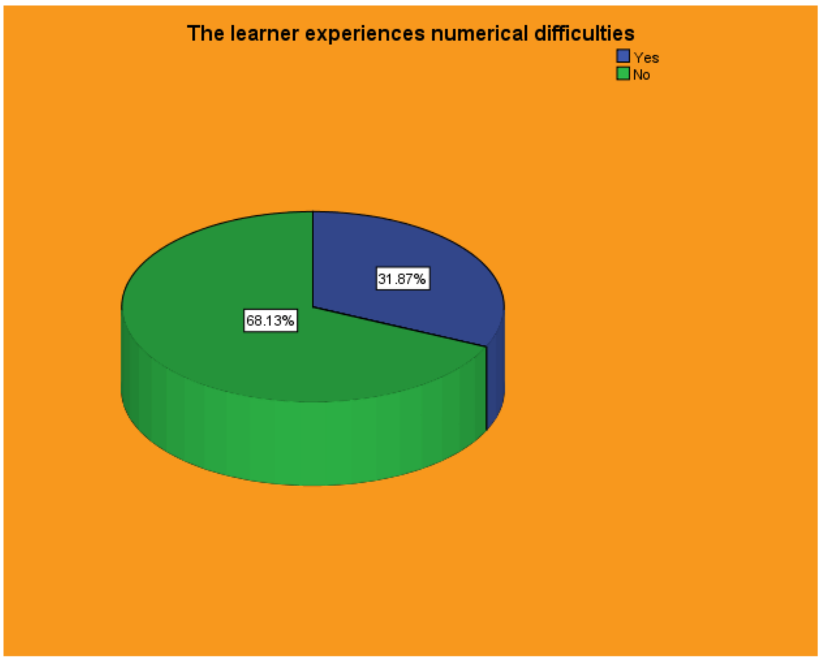


From the figure above, majority of the learners (92.5%, n=86) claimed they never experience difficulties with writing English. A meagre 7.5%, n=7 claimed the contrary. This does not agree quite well with the previous analysis where the researcher found that a great majority (92.5%) of the respondents never experiences difficulties in reading English, nor do they have numerical difficulties.

The implications are that there must be good performance by the interviewed learners since; a significant percentage of learners have no difficulties in reading English, nor do they have numerical difficulties and learners have no difficulties writing English. The researcher knows quite well that a reasonable grasp of the English language gives learners an added advantage over those whose ability in English hampers them from good performance. According to Mji and Makgato (2006), the language of instruction - English in this case, is generally a problem on its own, learners' understanding is affected when there is overlaps in usage and result in alternative conception. Hence, language contributes to one's ability to understand any given subject.

The graph in Figure 4.25 is a follow up to the two figures above. It presented information on learners' experiences with numerical difficulties.

Figure 4.25: Numerical difficulties experienced by the learner



From the figure above, majority of the respondents (68.13%, n=64) never experienced numerical difficulties during their science lessons. However, 31.9 %(n=29) of the respondents experienced serious difficulties during their science classes.

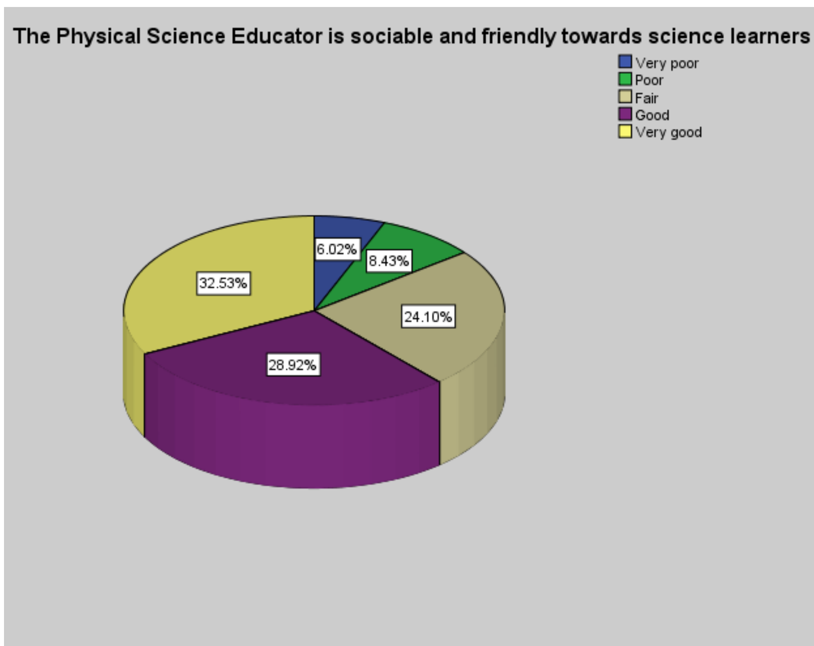
The researcher observed that 31.9% of learners in the target group are a large number whose attention should not be ignored.

Converted to a number, 31.9% is too huge. It goes without saying that science learners experience numerical difficulties that need attention. The reason for this kind of concern by the researcher is that failure for the science learners to perform numerical calculations efficiently means that the same learners will have equal difficulties in all science subjects including Mathematics.

In Figure 4.26, Figure 4.27, Figure 4.28, and Figure 4.29, presented information on how science learners rated their science teacher in terms of certain traits possessed by the teacher.

In Figure 4.26, learners rated their teacher on aspect of sociability and friendliness towards learners.

Figure 4.26: Aspects relating to sociability and friendliness of the teacher

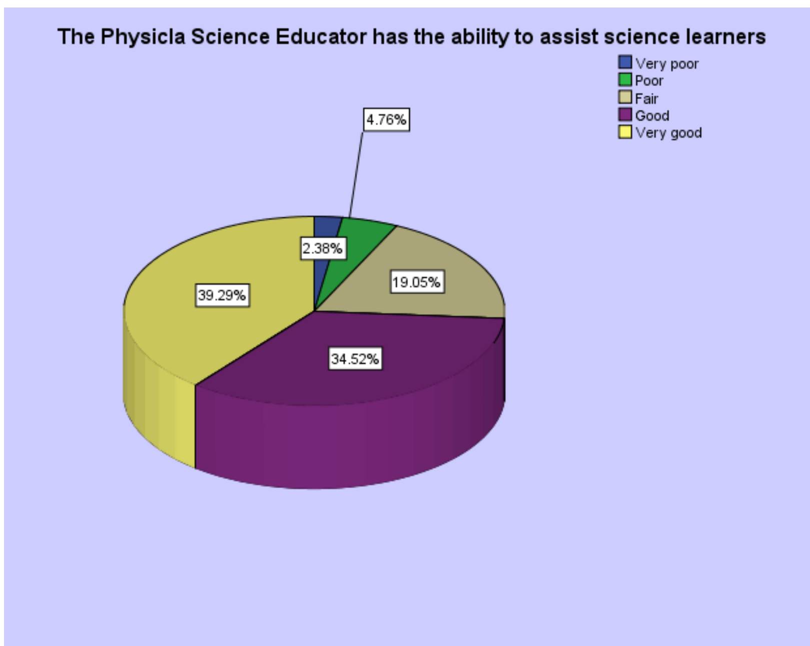


The results of the graph shows that the majority (32.5%, n=30) of the respondents rated the statement as "very good." The rating was followed by 28.9 % (n=27) who rated the statement as "good". The lowest among the response percentages was "very poor" which was rated by 6% (n=5) of the whole learner response. Other response percentages are easily observable from the chart.

Majority who rated the statement as "very good" classification which when this percentage is collapsed with the responses "good", and "fair", the resulting total was 85.5%. This is a very high percentage for those who either rated the statement as fair, good or very good. Thus, the balance of the negative response rating, forming a collapsed total of 14.5% was comparatively far smaller than those who gave a collapsed total positive response percentage of 85.5%. On a balance of probability, any interested reader would develop a feeling that the statement is correctly stated.

The graph in Figure 4.27 indicates learners' views about the teachers' ability to assist them during science lessons.

Figure 4.27: Ability of the teacher to assist learners

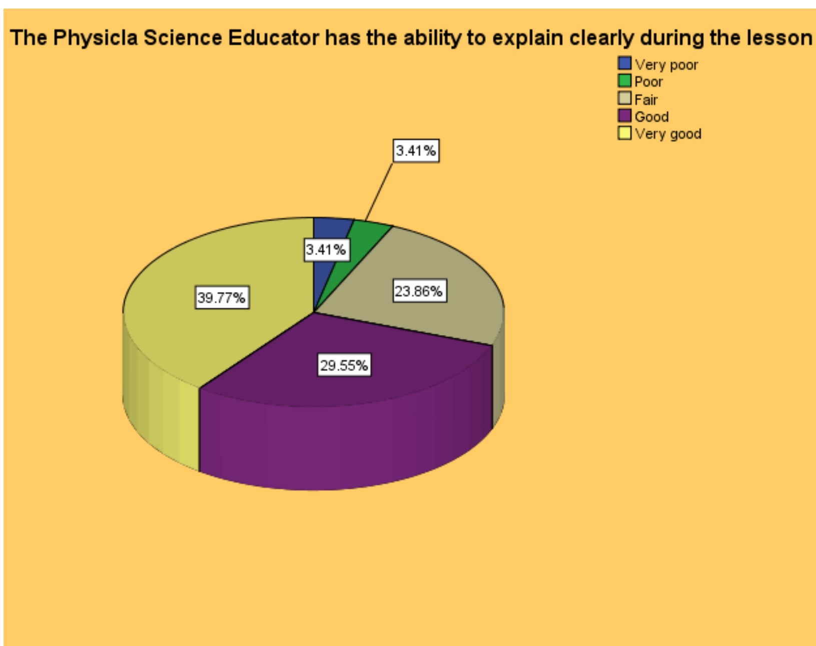


From the graph above, majority of the respondents (39.3%, n=37) rated the statement to be "very good." This rating was followed by 34.3 %(n=32) of the respondents who rated the statement as "good." The least among the response percentages is 2.4% (n=2) which was for those who rated the statement as "very poor". The researcher collapsed the positive response percentages and the negative response percentages and got the following collapsed percentages obtaining response percentages of: 73.8% and 7.2% for positive and negative ratings respectively.

This shows that the overall rating for the Physical Sciences educator was high at close to 74%, though the researcher noted with concern that there is a credibility room for serious improvement. The ability to assist science learners improve in their class work is very important and must be given priority on the agenda list of any science teacher in particular and any teacher in general.

Figure 4.28 is a follow up to the two graphs above. The graph below presented information on the views of learners with regard to their teachers' ability to explain science concepts clearly.

Figure 4.28: Ability of the teacher to explain clearly

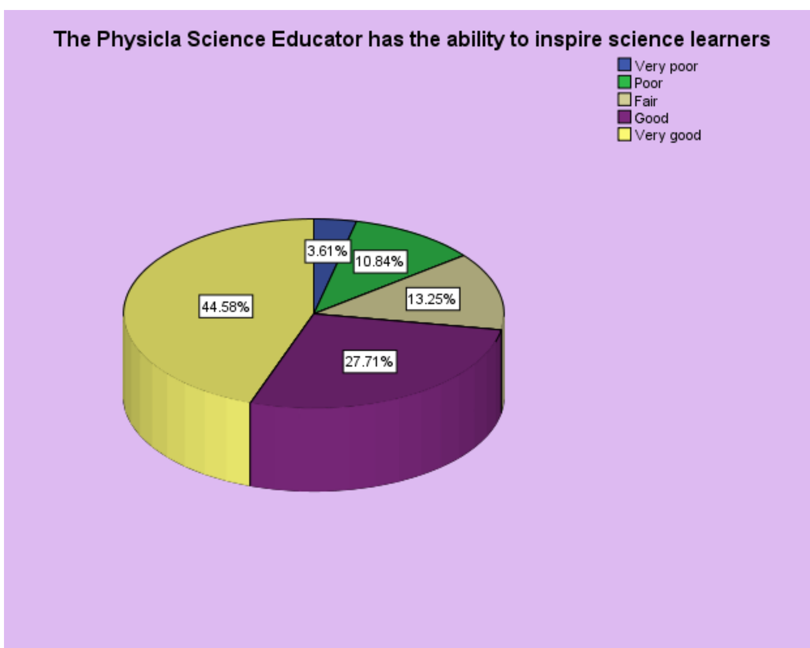


According to the analysis on the figure above, majority (39.8%, n=37) of the respondents rated the statement as "very good". The second in the order of magnitude, 29.5% (n=28), rated the statement as "good". The least among the response percentages is 3.4 % (n=3) which were for those who rated the statement as “very poor.”

The researcher collapsed the positive response percentages obtaining a majority response rating of 93.2%. This collapsed percentage was for those whose ratings were very good, good or fair. When the negative response percentages (for very poor or poor) were collapsed, the resulting total percentage was only 6.8 % (n=6). A comparative analysis between the two collapsed percentage groups shows that the collapsed positive percentage is far higher than the collapsed negative percentage which shows that the great majority of the respondents positively rated the statement.

Below is a graph (figure 4.29) presenting learners views on their teachers’ ability to inspire science learners to learn Physical Sciences.

Figure 4.29: Ability of the teacher to inspire learners



According to the statement, the analysis shows that the majority of the respondents (44.6%, n=42) rated the statement as “very good”. The second in order of magnitude was 27.7%, n=26) who rated the statement as “good”. When the researcher collapsed the positive response percentages, she obtained a collapsed response rating of 72.3%. This represented the number of respondents who rated the statement as either “very good or good”. The other collapsed total for the negative responses was 14.4% (n=13). The 72.3% of the response rating of the statement positively shows that the Physical Sciences learners have confidence in their teacher and are sure of being inspired to final success.

4.3.3 Learners’ opinions about their teacher and the learning activities in science lessons

This section presented the opinions of learners with regard to their school and the teaching and learning activities that occur during their Physical Sciences lessons. Aspects such as number of experiments performed, time spent on each topic, learners’ attitude towards the subject, and etcetera was covered. A five Likert scale of strongly disagree, disagree, uncertain, agree and strongly agree was used to measure levels of agreement or disagreement. To ease the discussion of the table, positive responses of “agreed and strongly agreed” were grouped together as agreement to the statements. Negative responses were grouped together as disagreement to the statements.

According to the analysis of the table below, majority of the Physical Sciences learners agreed to the following statement; I am always excited during physical science lessons (55.9%, n=52); Science lessons are interested enough to keep me attentive(67.7%, n=63); My science teacher spends enough time on each topic (55.9%, n=52); My science teacher is always concerned about our understanding of each topic(65.6%, n=61); I see Physical Sciences as too abstract (44.0%, n=41); I see physical science as related more to the environment (72.0%, n=67); and I understand most of the science concepts we have encountered in the lessons (59.1%, n=55).

Furthermore, positive responses were also given in other statements such as: I am given the opportunity to ask questions during the science lessons (84.8%, n=79); All learners are treated fairly by the science teacher (82.8%, n=77); The science teacher provides support to all learners during lessons (68.8%, n=64); The science teacher is always punctual to class (78.5%, n=73); we are always given homework (73.1, n= 68).

Table 4.8: Learners' opinions about the teaching and learning activities in science lessons

LEARNERS' OPINIONS	n / %	RATING OF LEARNERS' OPINION ON A SCALE OF 1 TO 5					
		STRONGLY DISAGREE	AGREE	UNCERTAIN	AGREE	STRONGLY AGREE	TOTAL
I am always excited during physical science lesson.	n	6	10	25	31	21	93
	%	6.5	10.9	26.9	33.3	22.6	100
Science lessons are interested enough to keep me attentive.	n	5	8	17	32	31	93
	%	5.4	8.6	18.3	34.4	33.3	100
My science teacher spends enough time on each individual topic.	n	3	17	21	22	30	93
	%	3.2	18.3	22.6	23.6	32.3	100
My science teacher is always concerned about our understanding of each topic.	n	6	12	14	23	38	93
	%	6.5	12.9	15.1	24.7	40.9	100
We have done many experiments in Physical Science.	n	25	15	20	13	20	93
	%	26.9	16.1	21.5	13.9	21.5	100
We are always given the opportunity to perform experiments individually.	n	29	18	14	17	15	93
	%	31.2	21.5	28	25.8	16.1	100
We are able to discover scientific concepts all by ourselves.	n	14	16	32	18	13	93
	%	15.1	17.2	34.4	19.4	14	100
I see physical science subject as too abstract.	n	6	20	26	24	17	93
	%	6.5	21.5	28	25.8	18.3	100
I see physical science as related more to the environment.	n	3	6	17	35	32	93
	%	3.2	6.5	18.6	37.6	34.4	100
I understand most of the science concepts we have encountered in the lessons.	n	2	14	22	31	24	93
	%	2.2	15.1	23.7	33	25.8	100
I am given the opportunity to ask questions during science lesson.	n	1	1	12	29	50	93
	%	1.1	10.8	19.4	29	53.7	100
All learners are treated fairly by the science teacher.	n	4	3	9	27	50	93
	%	4.3	3.2	9.7	29	53.7	100
The science teacher provides support to all learners during lesson.	n	1	10	18	27	37	93
	%	1.1	10.8	19.4	29	39.8	100
The science teacher is always punctual to class.	n	2	6	12	25	48	93
	%	2.2	6.5	12.1	26.9	51.6	100
We are always given homework.	n	2	10	13	27	41	93
	%	2.2	10.8	14	29	44	100

From these findings the researcher concluded that, the fact that the majority of the respondents were excited during Physical Sciences lessons indicates that the teachers are fairly supportive and competent. According to Hughes and Chen (2011: 278), supportive and positive relationship between teachers and learners ultimately promote a sense of school belonging and encourages learners to actively involved in class activities.

The researcher noted that the fact that Science lessons are interesting enough to keep learners attentive means that the concerned teachers are so committed that the majority of the learners are never bored and they never get stressed with their lessons. According to Kruger and Steinman (in Deventer and Kruger, 2003: 15), a science teacher who possesses a good management skills is able to create a teacher-learner relationship that motivates learners to learn. These results from the table further confirmed a statement by Kriek and Grayson (2009). They were of the view that when science teachers used varied materials to perform experiment, learners develop conceptual understanding and experimental skills.

These results suggest according to the researcher, giving learners the opportunity to ask questions during science lessons by their educators has encouraged learners to perform well as they operate under a friendly environment and they never feel frightened. In addition, Lin and Tsai (2009:193) indicated that learning environment that is learner-centred and peer interactive help students develop more fruitful conceptions of the learning environment than other methods.

Further results obtained from the table indicated that an average majority of the Physical Sciences learners considered the subject to be too abstract for them to comprehend. This implies that the majority never grasped whatever goes on in class. According to CAPS document (DBE, 2011:8), Physical Sciences is a study subject of investigating physical and chemical phenomena. This is done through scientific inquiry and application of scientific models.

Further analysis of Table 4.8 revealed that majority of the respondents indicated disagreement to the following statements: We have done many experiments in science with our teacher this year (43.0%, n=40); and we are always given the opportunity to perform experiments individually. These suggest that learners have never done any experiments in school this year or they have done only few experiments. These results suggest that, an above average number of Physical Sciences learners suffer from lack of individual practice as well as individual attention during practical classes which they find being disadvantaged. The researcher finds that assistance at individual level is very important and highly required by learners.

Conversely, majority of the learners were uncertain (34.4%, n=32) about their ability to discover scientific concepts all by themselves. The end analysis indicates that a great majority of learners do not know whether they have made any discoveries of scientific concepts. The researcher observed that discovering scientific concepts is an idea which is cherished by many observers. According to Rochelle *et al*. (2000:79), when students are actively engaged in constructing knowledge from a combination of activities, they are more likely to gain expert understanding of science concepts in the laboratory. The results suggest that the respondents understood the efforts made by different science teachers. These results further confirmed a statement by Etkina *et al*. (2002: 352). They indicated that learners benefit from experimental work by observing phenomena to collect data and hence, according to Barton, through experimentation understanding of scientific concepts is enhanced (Barton, 2004).

4.3.4 Use of ICT in teaching and learning of Physical Sciences

This section presents learners' views and opinions on the use of ICT in teaching Physical Sciences in the resource centre and the laboratory. The section covers aspects such as: the teacher uses ICT in teaching; ICT should be used in teaching; teachers should be trained on ICT use, and etcetera.

Table 4.9 below presents information on learners' views about the importance of using ICT in science teaching and learning.

Results of analysis from the table show that of the twelve statements given under section D of the questionnaire for learners, majority of the learners are in agreement with eleven of the statements given in the section. The following are the statements they agreed on:

Statement 1: Teachers should be trained to use ICT in teaching science (59.1%, n=55)

Statement 2: ICT should always be used in teaching science topics (60.2%, n=56)

Statement 3: ICT usage should be integrated with traditional normal teaching methods (68.8%, n=64)

Statement 4: ICT usage makes teaching science easier (51.6%, n=48)

Statement 5: ICT usage saves time used to draw and label diagrams on chalk board (82.7%, n=77)

Statement 6: ICT usage in teaching makes diagrams clearer (75.3%, n=70)

Statement 7: ICT usage in teaching captures learners attention (73.1%, n=68)

Table 4.9: The use of ICT in the teaching and learning of Physical sciences

TABLE 4.5 : ICT USE IN THE TEACHING AND LEARNING OF PHYSICAL SCIENCES							
ICT USE IN THE TEACHING AND LEARNING OF SCIENCE	n	ICT USE IN THE TEACHING /LEARNING OF SCIENCE ON A RATING OF 1 TO 5					
	%	STRONGLY DISAGREE	DISAGREE	UNCERTAIN	AGREE	STRONGLY AGREE	TOTAL
The teacher uses ICT(simulation and data-logging)to teach science	n	44	14	11	14	10	93
	%	47.3	15.1	11.8	15.1	10.7	100
Teachers should be trained to use ICT in teaching science	n	12	13	13	28	27	93
	%	12.9	13.9	13.9	30.1	29	100
ICT should always be used in teaching science topics	n	6	12	19	25	31	93
	%	6.5	12.9	20.4	26.9	33.3	100
ICT usage should be integrated with traditional normal teaching	n	5	10	14	42	22	93
	%	5.4	10.8	15.1	45.1	23.7	100
ICT usage makes teaching science easier	n	3	6	36	23	25	93
	%	3.2	6.4	38.7	24.7	26.9	100
ICT usage saves time used to draw and label diagrams on chalk board	n	2	6	9	28	48	93
	%	2.2	6.4	9.7	30.1	51.6	100
ICT usage in teaching makes diagrams clearer	n	3	3	16	26	45	93
	%	3.2	3.2	17.2	27.9	48.3	100
ICT usage in teaching captures learners attention	n	5	3	16	25	44	93
	%	5.4	3.2	17.2	26.8	47.3	100
ICT usage in teaching controls the class	n	5	10	26	29	23	93
	%	5.4	10.8	27.9	31.2	24.7	100
ICT usage in teaching brings excitement in learners	n	3	3	16	26	45	93
	%	3.2	3.2	17.2	27	48.3	100
ICT usage makes it easier for learners to visualise lessons	n	5	7	11	37	33	93
	%	5.4	7.5	11.8	39.8	35.5	100
ICT usage makes imaginary concepts real	n	6	9	14	19	45	93
	%	6.5	9.7	15.1	20.4	48.3	100

- Statement 8: ICT usage in teaching controls the class (55.9%, n=52)
- Statement 9: ICT usage in teaching brings excitement in learners (75.3%, n=70);
- Statement 10: ICT usage makes it easier for learners to visualize lessons (74.2%, n=69); and
- Statement 11: ICT usage makes imaginary concepts real (70.9%, n=66).

This showed that the agreement with statement 1, (whether strongly agree or just agree) was a representation by the majority of the respondents. Majority of the Physical Sciences learners are convinced that their educators should be trained on the use of ICT for teaching. Overall, the analysis shows that the Physical Sciences teachers are not technology literate as far as the use of ICT for teaching is concerned. It is proper that the use of ICT for teaching be implemented nationally as this will lead to convenient teaching and achievement of many educational goals.

In addition, the results indicate that according to the percentage output on the analysis of the responses for statement 2, majority of the Physical Sciences learners would love to be taught by use of ICT, particularly when being taught Physics. According to Osborn and Hannessy (2003), the use of ICT in science laboratory can strengthen procedural knowledge. Procedural knowledge is the expertise of knowing 'how' to do something, over and above knowing 'what' something is.

The results according to the percentage data analysis based on the responses for statement 3, the majority of the Physical Sciences learners strongly recommend the integration of ICT into the teaching system with the traditional teaching methods. They feel this will go a long way in improving of teaching and learning of Physical Sciences. Therefore, research shows that ICT has the potential to support education across the curriculum and provides opportunity for teachers and learners to communication effectively (Dawes 2001).

Furthermore, results on statement 6 indicate the majority of the Physical Sciences learners with the view that ICT usage makes diagrams clearer than drawing them on the chalkboard by hand. An overwhelming majority of the respondents understand the introduction of ICT into schools as time saving and appropriate enterprise according to statement 6. The use of ICT will definitely improve classroom work in each and every topic of teaching and learning.

The analysis results on statement 7 indicate that the collapsed majority of the combined response shows a significant support for the use of ICT which learners claimed captures their attention in class. Capturing the attention of learners in class is the biggest achievement a teacher can ever have. Hence, Hitchcock (2001) is of the view that ICT enables teachers to pay more personal attention to each student to ensure that every learner functions within his or her "zone of proximal development.

The results on statement 8 indicated the majority of the Physical Sciences learners who suggested that ICT usage helps teachers to control their class. They suggested that, learners will concentrate more seriously if ICT is used in the lesson than in a normal class. All school managements know that class control is a great achievement.

The analysis on statement 9 indicates that an overwhelming majority (75%) support the hypothesis that the use of ICT brings additional excitement to learners which will make a class to be more active than otherwise.

From the results on statement 10, majority affirmed that the use of ICT in teaching makes it easier for learners to visualise the lesson. Learners visualise the classroom concepts from a more practical angle than when teaching is conducted without the use of ICT. This leads to greater understanding of the concepts by the learners. According to Collins (1991), people remember visual information more easily than verbal information. Having access to visual materials may extend people's ability to learn.

On statement 11, majority of the Physical Sciences learners were of the view that the use of ICT in teaching makes imaginary concepts such as magnetic field to appear more practical and real as the presentation in class will be viewed from a more practical perspective. Hence, Cigrik, and Ergul (2009) and Ogbonaya (2010) reported increased learner achievements in their studies when computer simulations were used in teaching.

Further analysis revealed that majority of the respondents (61.2%, n=57) disagreed with the first statement on the table. According to the percentage output based on the analysis of the responses, majority of the Physical Sciences learners were never taught in class or the laboratory with the ICT (computer simulation). Hence, these learners are deprived of the numerous benefits accruing from using the ICT in science teaching. Consequently, literature indicated that the use of ICT as modern technology is getting popular in many advanced schools. These technologies are quite expensive to afford and so it is not surprising that the majority never use these facilities).

4.3.5 Factors influencing ICT use in schools

This section presents factors that influence the use of ICT in schools. Statements including aspects such as: The government has made ICT infrastructure available to schools; CAPS curriculum permits ICT use in teaching science in schools; Teachers have access to software programmes which support the CAPS documents, and etcetera were considered.

A rating scale of 1 to 5 attributed to “strongly disagree”, “disagree”, “uncertain”, “agree” and “strongly agree” were used to measure levels of agreement and disagreement to the statements indicated in the table. To make it easier to discuss the Table 4.10, a rating attributed to “strongly disagreed and disagreed” were combined together as a disagreement. The positive responses attributed to “agreed and strongly agreed” were combined together as an agreement.

From the Table 4.10, majority of respondents disagreed with the following statements:

Statement 3: My school’s time table allows practical work in science with the use of ICT (64.5%, n= 60).

Statement 7: Learners have access to software programmes which are compatible to CAPS documents (63.4%, n=59.)

Statement 10: Learners can learn science with ICT on their own without help from teacher (39.8%, n=37).

Statement 11: My school has enough computers for all science learners ((69.9%, n=65).

Statement 12: All schools in my district have ICT infrastructure (58.0%, n=54).

Table 4.10: Factors influencing the use of ICT in schools

4.9: FACTORS INFLUENCING ICT USE IN SCHOOLS							
ICT USE IN SCHOOLS	n	RATINGS OF ICT USE IN SCHOOLS ON A SCALE OF 1 TO 5					
	%	STRONGLY DISAGREE	AGREE	UNCERTAIN	AGREE	STRONGLY AGREE	TOTAL
Government has made ICT infrastructure available to schools.	n	14	20	34	14	11	93
	%	15.1	21.5	36.5	15.1	12	100
CAPS curriculum support ICT usage in teaching Physical Science.	n	14	13	24	30	12	93
	%	15.1	13.2	25.8	32.2	12.2	100
My school's time table allows practical work in Physical Science with the use of ICT.	n	32	28	15	9	9	73
	%	34.4	30.1	16.1	9.7	9.7	100
The content of Physical Science CAPS document permits the use of ICT in teaching Physical Science.	n	11	13	40	21	8	93
	%	12	14.1	43	22.6	8.6	100
The data-logging and the simulation software programs available currently are compatible with the South African CAPS document.	n	7	13	45	22	6	93
	%	7.5	13.9	48.4	23.1	6.5	100
My teacher has access to software programs which support the CAPS documents.	n	13	15	31	26	8	93
	%	14	16.1	33.3	27.8	8.6	100
Learners have access to software programs which are compatible to CAPS document.	n	31	28	17	12	5	93
	%	33	30.8	18.27	12.9	5.4	100
The use of ICT in teaching Physical Science is time consuming.	n	14	14	38	16	11	93
	%	15.2	15.2	38	17.4	14.1	100
Learners get too excited when ICT is used in teaching Physical Science.	n	13	16	20	26	17	93
	%	14.1	17.4	21.5	28.3	18.5	100
Learners learn physical science with ICT on their own without the help from their teacher.	n	15	21	25	17	15	93
	%	16.3	22.8	26.1	18.5	16.3	100
My school has enough computers for all Physical Science learners.	n	49	15	13	7	8	93
	%	52.7	16.5	14.3	7.7	8.8	100
All schools in my district have ICT infrastructure.	n	36	18	31	1	7	93
	%	38.7	19,	33	1.1	7.7	100

The results of the analysis obtained from statement 3 reveals information to the effect that many schools never allowed learners to do practical work in Physical Sciences with the use of ICT due to the fact that the time table allows for one hour maximum time for all subjects.

Furthermore, the analysis on the statement 7 shows that the government through the Department of Education has not properly supplied and equipped learners with the required software for programmes which are compatible with the CAPS documents. The CAPS document requires software compatibility in order for it to function sufficiently.

In addition, statement 10 analysis shows that the responding learners have never been adequately exposed to an ICT class where they could or could not understand the effectiveness of ICT operations in a classroom setup. There is, therefore, a need for this exposition of learners to these modern but useful facilities.

Moreover, the analysis on this statement 11 shows that the government through the Department of Education has not properly supplied and equipped learners with the minimum computing facilities and the necessary equipment software for proper learning particularly those who do science subjects. The distribution of response percentages leaves one with only one guess, “some schools are treated better than others”. The response pattern to this statement shows the existence of biased treatment of some schools. This study has uncovered this truth.

As a follow up to statement 11, learners disagreed with statement 12 since not all schools in their district have the ICT infrastructure. The analysis on this statement shows that the government through the Department of Education should supply and equip schools in the target area and other parts of the province with the recommended computers, the required software and the manpower to train teachers, the learners and those other people who may use the computing facilities of the school. The response percentages received demonstrate that only 8.6% of the whole target community has been equipped with ICT infrastructure.

Hence, it is important to highlight from Table 4.10 that some learners strongly agreed or agreed with the following statement: Statement 2: the CAPS curriculum support ICT usage in teaching physical science (44.0, n=41); Statement 6: my teacher has access to software programmes which support the CAPS documents (35.5%, n=33); and Statement 9: learners get too excited when ICT is used in teaching physical science (46.2%, n=43).

The analysis on statement 2 revealed that the government, through the Department of Education, has not properly instituted the ICT support for the CAPS curriculum in the teaching of Physical Sciences. Hence, Hannatu (2014) pointed out that, ICT should be introduced into the science curriculum due to its numerous advantages in promoting learners intellectual qualities through higher order thinking, problem solving, improved communication skills and deep understanding of the learning tools and concepts to be taught.

The analysis on statement 6 shows that the government through the Department of Education has not properly instituted the proper guidelines to the distribution and use of software programs which support the CAPS documents. The analysis supports this assumption based on the output percentages of the statement and its implications on the summary of this statement. A few learners who indicated that they have access to ICT infrastructure in their schools agreed with this statement.

The analysis on this statement 9 shows that though the majority has supported the statement, it must be remembered that those who gave negative responses plus those who were uncertain count more heavily than the positive response percentage. As a result, the researcher wishes a further study to analyse these additional observations.

Further analysis of the table indicated that quite a number of learners were uncertain about the following statements:

- Statement 1: Government has made ICT infrastructure available to schools(37.6%, n=35)
- Statement 4: The content of physical science CAPS document permits the use of ICT in teaching physical science(43.0%, n=40)
- Statement 5: The date logging and the simulation software programmes available currently are compatible with the South African CAPS documents (48.3%, n=45).
- Statement 8: The use of ICT in teaching physical science is time consuming (38.7% n=36).

Analysis on statement 1 shows that the government through the Department of Education has not endeavoured to change the teaching and learning structure in most high schools and thus the mixed responses by the learners which shows that those for and against this topic were almost at par. The researcher comments that the government must take the initiative to launch ICT facilities in schools since, ICT usage in science teaching is important for providing opportunity for learners to learn to operate in a technological world (Khalid, 2009).

Analysis on statement 4 shows that the government, through the Department of Education, has not clearly spelt out its commitment to the content of the Physical Sciences CAPS document to permit the use of ICT in the teaching of Physical Sciences in different schools in the province in particular and the country in general.

Further analysis on statement 5 revealed that government through the Department of Education has not properly educated learners and even educators on the applications of ICT for good usage. This is the reason for the undefined responses (response confusion) where the percentage for the positive response (22%) is almost equal to the percentage for the negative response (29.7%).

Therefore, there is dire need for the system to equip educators and the concerned learners on the use of ICT with particular emphasis on data-logging and simulation software programs which are currently available with the South African CAPS documents.

This analysis on statement 8 has a number of implications including the possibility of having interviewed learners whereas some of them do not know anything about the use of ICT. According to Hitchcock (2001), ICT usage enables teachers to give individual attention to each student to ensure that every learner functions within his or her "zone of proximal development". Hence, schools without ICT resources are deprived of the benefits of teaching and learning with ICT.

4.4 INTERVIEW DATA ANALYSIS AND INTERPRETATION

4.4.1 Introduction

This section reports on the results of data collected from the semi-structured interviews conducted with Physical Sciences learners, teachers, and school principals in Mthatha. The aim of the interview as mentioned in previous chapters was simply to provide in-depth analysis and to "add on" what had been established from the quantitative study.

A good example is this item: "ICT should always be used in teaching Physics topics." Results for this item shows 60, 2% of learners opting for a positive response – strongly agreed or just agreed and 39, 7% opting for – uncertain, disagreed or strongly disagreed. This suggests that a high percentage of learners are in support of the use of ICT in teaching science. Nonetheless, it is not clear why they opted for use of ICT in science teaching. That was the reason why the study was supplemented with semi-structured interviews.

A very brief analysis and interpretation of data obtained from transcripts of individual interviews is given and supported by literature. Following the coding of the participants' transcribed responses in terms of the main research questions and interview questions, five themes were identified. Hence, interview questions were structured differently for learners, teachers and principals, but were based on the same themes. For the sake of convenience, schools are addressed as School A to G, Principals are addressed as Principal A to G, Physical Sciences teachers are addressed as Teacher A to G and Learners are addressed as Learner A to D.

4.4.2 The Themes of the semi-structure interview questions

The following indicates the themes under which the interview responses were transcribed for the different participants (principals, teachers, and learners):

Theme 1: Use of science laboratories and resource centres to improve learner performance.

Theme 2**:** Strategies employed in teaching Physical Science in laboratories.

Theme 3: What account for the falling performance levels of learners in Physical Sciences?

Theme 4**:** Educational benefits of using the laboratory and the science resource centre.

Theme 5: The educational challenges of using the laboratory in teaching science.

4.4.3 FINDINGS, DISCUSSIONS, AND INTERPRETATION OF INTERVIEW RESULTS

4.4.3.1 Theme 1: Use of science resource centres and laboratories to improve learner performance

Findings and Discussions

Learners

All the four learners interviewed indicated that to improve their performance in Physical Sciences, there must be an extended time allocated to the subject on the timetable and learners should be given ample time to practice. This view was shared by Gunstone and Champagne (1990). They suggested that meaningful learning in the science laboratory would occur if students were given sufficient time and opportunities for interaction and reflection. In addition, Gunstone reports that students generally did not have time or opportunity to interact and reflect on central ideas in the laboratory since they are usually involved in technical activities with few opportunities to express their interpretation and beliefs about the activities at hand.

In addition, Learner A and Learner B were of the view that, their schools must find skilled and professional science teachers who will ensure that all of their students understand every topic of Physical Sciences. All the learners were of the view that Physical Sciences should be taught combining theoretical and practical activities and hence using examples relating to the environment. In view of this, NIED (2005:1) suggested that the teaching of theoretical lessons must proceed with practical work on the topics covered in the theoretical lessons. Through this process, learners' knowledge and understanding of a particular concept in science are enhanced and consolidated by the practical experiences they go through after each theoretical lesson.

On the question of whether the school provides text books to learners, learner D from one of the private schools indicated that his school does not provide any textbooks. They buy the books themselves. The learners (A and B) from the public schools indicated that their schools provide text books and sometimes study guides. Learner C responded:

> *"Even if the school provides us with textbooks, and study guides, we still experience the difficulties of not understanding Physical Science, because we as learners need a good science teacher to explain most of the concepts essential for Physical Science."*

Teachers

Three science teachers (B, D and E) on the other hand explained a science resource centre as a facility that provides opportunities for students to experience scientific phenomenon on a first hand bases. Also, teachers C, F and G indicated that it (science resource centre) is an area where learners can perform experiments and expose themselves to laboratory equipment and it is bigger than a laboratory. Teacher A responded:

> *"A resource centre is a centre for science teachers that support them in their teaching."*

Teachers D and B also viewed the science laboratory as a place where teachers and learners can do experiments on various science topics such as photoelectric effect and electrochemical reactions.

On the question of usage of resources in teaching, teachers A, C, D and E indicated that sometimes they use resources in teaching while, Teachers B, E and F were of the view that they do not use resources due to overloading of classes, inadequate knowledge on usage of apparatus, non-availability of ICT facilities, and hence, they focus on the completion of syllabus and have no time taken learners to the laboratory for experiment. Research shows that by using resources and by seeing teachers demonstrating or conducting experiments themselves, learners' supplement what is in textbooks and thereby, enhancing learning (Mji & Makgato, 2006). An advantage is that it helps improve learners' higher order learning skills such as analysis, problem solving, and evaluation, at the same time, supplementing the learning process (Mji, & Makgato, 2006).

On answering to the resources that have been procured and distributed to schools, the private school teacher F and Teacher G responded that, the Department of Basic Education have not yet distributed any science equipment to their school. Conversely, the public school teachers (A, B, C, D, E) affirmed that the government had supplied their schools with science kits, mobile laboratories, DVDs, projectors, laptops, to enhance understanding of scientific concepts.

On the question of performance of learners with well-equipped science laboratories, teachers A, B, C and D indicated that schools with well-equipped science laboratories usually, perform better. Teacher E and G responded that there is no difference in performance of learners in schools with well-equipped science laboratories and without laboratories. Teacher F from a public school highlighted*:*

> *"Performance mostly depends on the teachers' workload and number of learners in each class. If classrooms are overcrowded, teachers would be biased and concentrate on the learners that are hard workers only. But if class is manageable then learners will be all attended to. In such a situation, having a well-equipped laboratory and without laboratory does not matter."*

Literature revealed that when resources are available, relevant, and adequate, they improve the academic achievement of learners in Physical Sciences (Hallack, 1990 as cited by Adeogun, 2008: 145).

Principals

All the school principals agreed to the fact that the South African government has prioritised science education in the national education agenda. The principals in responding to the proposal and establishment of resource centres and laboratories, four principals: A, C, E and F were of the view that science laboratories were proposed and established to promote and create enabling environment for teaching and learning of sciences, to improve and encourage science learning in schools and making science learning real and practical.

On individual opinions on what can be done to improve Physical Sciences results in schools, five principals (B, C, D, E, F) highlighted the following:

> *Schools should build strong interest in the subject to attract learners to study science, resources procurement must be enhanced, employing qualified personnel to teach the subject, and organise regular in-service training for educators to upgrade their content,*

Two other principals (A and G) also gave their responses as:

> *Schools should monitor the teaching of the subject, increase the knowledge and skills of teachers, change the content, alter the relationship of the student to the teachers and the content and lastly to complete the syllabus on time for revision*.

Hence, according to DoE (1997a: 17), there has been a shift in learning; this shift demands learners to become active participants in their learning process and are also expected to take responsibility for their own learning.

4.4.3.2 Theme 2: Strategies that are employed in teaching and learning science in science resource centres and laboratories

Findings and Discussions

Learners

The findings regarding strategies employed in teaching Physical Sciences in the laboratories revealed that the learner from School G has never done any laboratory activity in school. He highlighted:

> *"The teacher would only tell us about things such as acids or read about it, we do not actually see these things in practical or in reality".*

Learner A responded that they do practicals in the laboratory which improve their understanding. He continued to say that; it is not easy to forget something you once observed or experienced than something you were once told. Hence, Johnstone and Al-Shuaili, (2001 as cited by Hofstein *et al*. 2008:61) maintained that the school's science laboratory can offer students opportunities to have more control on their activities, enhance their perception of ownership and motivation. Of significance is that learners will have opportunities to discover information on their own.

On the other hand, a learner E affirmed:

> *"We do practicals but I don't see any change of understanding of the subject though, we do them."*

In view of the above, Hodson (Hodson, 1990, as cited by *Hart et al*., 2000) criticises the laboratory and argues that the laboratory work is often dull and teacher-centred and learners often fail to relate the laboratory work to the theoretical aspects of their learning to enhanced understanding.

The findings also revealed that all learners were encouraged to work in groups. Although, they do all practical activities in groups, observations are recorded individually. Therefore, group work will enable all learners to be active and participate fully in the activities.

On the question of whether Physical Sciences learners have been allowed by teachers to come up with own topics to investigate, all learners responded that they have never been allowed to come up with own topics, because, at times when you come up with your own topic, the teacher will shut you up. This view is in contrast with the views of Domin. Domin (1999: 545) highlighted the effectiveness of giving learners ownership over laboratory activities (learner-centred) by allowing them to choose their preferred objectives from the Physical Sciences content.

Learner A and B responded that their practical investigations are related to theoretical topics like the titration of acids and bases. Learner C responded that most of the topics are related but some are just general knowledge. Learner D is of the view that:

> *"The practical works are not related to theoretical work because, in practicals, we use our hands to do some combinations".*

Interestingly, learners A and B added that, what they do in the laboratory is what they have been taught in the classroom. According to Bajah (1984 as cited by Abimbola, 1994), 'all science teachers and students know that experimental work is the 'gem' of science teaching' and therefore, should be integrated with theory to strengthen the concepts being taught (DBE, 2011).

Teachers

The teachers interviewed responded to the educational initiatives to embark on to enhance science learning. The following are the categories of responses given by teachers A, B, D, and E:

> *"Learners should be exposed to career guidance from role models in science oriented fields, field trips to exhibition centres, tour – learners should be taken to industries that are science-oriented to enable them to familiarise themselves with the career paths available to them in the course of their studies in sciences, science debates, and science weeks or days,*

Three teachers C, F and G also highlighted on the following:

> *The use of ICT in teaching- for example, simulation and data logging in teaching scientific concepts, team teaching, transition from abstract teaching to practical oriented teaching and frequent practical activities in schools"*.

Regarding the question on 'teachers' responses on how the availability and non-availability of resources affect science teaching', teachers E and G indicated that sometimes explaining a concept without using a resource to demonstrate to learners become very difficult. Kriek and Grayson (2009:193) confirmed this assertion by stating: when the teachers use the kit to perform experiments, both learners' conceptual understanding and experimental skills are developed. They added, when the science kit is used in their classrooms to demonstrate phenomena and explain concepts to their learners, both their teaching skills and the learners' understanding are improved.

Teachers perceived the absence of a laboratory as the main limitation towards effective teaching of science. Teachers A and D were of the opinion that, to improve Physical Sciences education, teachers should be equipped both in content and experimentation, while learners should be involved in the teaching and learning process through series of motivational strategies. Teacher B and C indicated that all stakeholders should play active role in the teaching and learning of science as a priority, and more practical lessons should be done in schools with learners.

Teachers E and G were of the view that schools should set up well-equipped laboratories and science resource centres, employ qualified teachers to teach from the foundation phase to Grade 12, give priority to Physical Sciences and Mathematics and encourage learners to read and learn and seek support from teachers. Teacher F indicated that learners should be motivated to change their attitude towards science, give more time to science in schools, and expose teachers to modern teaching style - the use of ICT in teaching science, and encourage competition among science learners in schools.

Principals

School principals B and C highlighted their responses as follows:

> "*To improve the performance of Physical Sciences in schools, teachers must use resources in teaching, knowing the content and identifying the relevant experiment to enhance the students' understanding".*

In addition, principal A, D, E and G shared a common view that:

> *"There should be active participation of students in the learning process, and the science teachers should establish the reality of science through experimentation, laboratory work, hypothesis testing, and inquiry."*

It was also found that sometimes explaining a concept without using a resource to demonstrate to learners become very difficult. This view was affirmed by Barton (2004), who emphasised that Physical Sciences requires demonstrable evidence of the validity of any theory. Part of teaching Physical Sciences is to bring about scientific thinking in learners: a mind that requires learners to test out through experimentation. Through experimentation, understanding of scientific concepts is enhanced (Barton, 2004). In view of this, teaching resources must be used in Physical Sciences lessons.

4.4.3.3 Theme 3: What accounts for the falling performance levels of learners in science?

Findings and Discussions

Teachers

The findings pertaining to what accounts for the falling performance levels of learners in Physical Sciences revealed the following categories from teachers A, D and F;

> *"The learners' attitude towards the subject, poor attendance to school, poor reading ability, poor understanding of scientific concepts due to lack of resources, lack of proper foundation, and learners not able to revise and practice science at home".*

Three other teachers B, E, and G responded to the falling performance of learners in Physical Sciences and indicated the following:

> *Mostly there is inadequate science resources, and the schools' lack of innovative and readiness to support teaching and learning of Physical Sciences.*

Principals

Two principals A and D interviewed suggested the following:

> *There is lack of commitment on the part of teachers to assist learners to work extra hard and lack of content knowledge of science educators.*

Five Principals; B, C, E, F and G and Teacher C shared a common view. They indicated that learner-to-teacher ratio is non-proportional and there are inadequate Physical Sciences teachers in the various schools.

These findings from the teachers and the principals corroborated with the literature reviewed. According to Hughes and Chen (2011), attitudes influence behaviours and behaviours in turn influence conduct and performance. Supportive and positive relationships between teachers and learners ultimately promote a sense of school belonging and encourages learners to actively participate cooperatively in laboratory activities (Hughes & Chen, 2011:278).

Furthermore, lack of resources result in a situation where teachers resort to traditional teaching methodology (Meier, 2003:232). Hence, learners are forced to memorise experiments than experimenting themselves. This situation has resulted in the teaching of Physical Sciences remaining at a theoretical level without any experiments to enhance understanding and application of knowledge (Mji & Makgato, 2006).

Hence, Naidoo and Lewin reviewed that learner performance is not solely dependent on the availability of resources but also on the effective use of the available resources by teachers to explain scientific concepts for understanding by learners (Naidoo & Lewin, 1998:72). In view of this, Physical Sciences concepts become more difficult for learners to learn. Therefore, the subject remains at a very theoretical level without any experiments to enhance the understanding and application of knowledge (Makgato & Mji 2006:254).

4.4.3.4 Theme 4: The educational benefits of using the laboratory and the science resource centre

Findings and Discussions

Learners

The findings on the educational benefits of using the laboratory and the science resource centres revealed the following from Learner A; "laboratory work is most exciting and interesting." "It gives me a broader picture and increases my understanding." "I am able to communicate with other learners sharing our ideas." "It makes my mind to imaging more effectively." Learner B responded;

> "*I just love being in the laboratory; it makes me feel like a real scientist"*.

These findings corroborated with the literature reviewed. According to literature, laboratory work is enjoyable in science courses and that laboratory experiences have led to positive and improved student attitude, perception and interest in science (Hofstein & Lunetta, 2004) meanwhile, Learner C indicated:

> *"Laboratory activity is so boring because, our teacher confuses us when we do an activity in the laboratory*."

Learner D did not know what to say. He stressed:

> *"Since we have not done any practical this year due to lack of resources, I cannot comment on that question."*

Teachers

The two teachers; Teacher A and Teacher B, highlighted on the following: Laboratory activities increase students' literacy in the field and provide foundation for a future in the scientific and technological labour force. In addition, Teacher C and D suggested that laboratory activities improve learners' ability to understand Physical Science. It increases performance of the subject, stimulating interest in learners and motivating them. Teacher E and F indicated that laboratory facilitates the reduction of abstractness to reality through experimentation; it enhances learner-centred teaching and makes science real, thereby making teaching fun. Teacher G responded: it stimulates learners' interest to participate in laboratory activity and eventually absorbs information that they would not get from normal tell me method.

Therefore, literature revealed that learners are better able to grasp new pieces of information and discern patterns when presented with numerous, effective examples of materials in the laboratory (Rose & Mayer, 2002).

Principals

On the other hand, school principals F and G stressed on the following as educational benefits of using the science resource centres and laboratory: "It reduces dependence upon authority." Also, learners are exposed to practical experiences in generating hypothesis and planning experiments. According to Principal D and E, laboratory activities make the learners more independent and reinforce learners' thinking by requiring interpretation of the observed events, rather than memorisation of correct responses. It also increases the inquisitiveness of learners. Hence, literature revealed that, learners' curiosity is enhanced during practical work, because they help learners to explore and ask questions (Lindt, 2000:57).

Furthermore, Principal A, B, and C shared a common view;

> *It plays a role of closing the gap between theory and practical experiment to facilitate as well as enriching the teaching and learning of sciences.*

Hence, literature revealed that, besides offering the hands-on experience, science laboratory teaches students how to make a scientific argument (Hofstein *et al*. 2007), conducting experiments, reviewing them closely, developing logical reasoning, and responding to analytical comments, are some of the valuable skills that help in preparing the next generation of scientists, engineers, and medical professionals.

4.4.3.5 Theme 5: The educational challenges of using the laboratory in teaching science

Findings and Discussions

Learners

The findings from the challenges of using laboratory in teaching science revealed the following from the learners:

Learners A and D indicated they do not understand what the question posed to them required and also not having a solid foundation with the teacher towards teaching skills and their inability to contain information in many topics. Learner A stressed:

"given the fact that the educator of this given subject does not know how to teach the subject very well, it makes it difficult to understand what is going on in the laboratory".

On the other hand, Learners B and C indicated they find the part involving calculations difficult. Also, there are inadequate resources in the laboratory when performing experiment. Hence, according to literature, the level of science learning is limited in the curriculum, and that learners are unclear regarding the aims of the practical work and are unsure of what the results mean or how they are applied to the theory provided in the teaching programmes (McGarvey 2004:17).

Teachers

The findings from the science Teacher A indicated that, sometimes learners want to prove something that was warned as dangerous. Teacher B said: Some learners have allergies to gases and experiences health problems such as respiratory problems. Teachers C and D stressed that

> "*A lot of preparations need to be done by the teacher before performing an experiment with the learners. Practical activities are often seen as isolated exercises, bearing little or no relationship with earlier or future work.*
>
> *There is lack of laboratory, lack of time to carry out an experiment, no laboratory assistance to assist the teachers in preparation towards experimental work, inadequate apparatus, (their suitability, and their functionalities) as well as the usage of them by the teacher."*

It was also revealed that Teacher E was not doing enough practical activities with the learners. The reason he gave was the subject content is too demanding, hence the focus is shifted on completing the syllabus, instead of wasting time in the laboratory. In addition, Teacher F complained about the chaos caused by learners and learners not following instructions. Also, Teacher G says, he finds it difficult to improvise and also to operate some laboratory equipment, like the ticker timer.

Therefore, literature indicated that, in South Africa, there is a poor output of science learners and pressure is on educators to improve results. This led to educators using survival strategies to ensure that results improve and, as such, the method compromises experimentation in the laboratory (Abd-El-Khalik & Lederman, 2000:670).

Principals

The findings from the Principals in response to challenges faced by science teachers in using the laboratory, Principal C and D highlighted on the following: lack of knowledge of content matter of some science teachers, and lack of resources in most schools. In addition, all the principals shared a common view and highlighted the attitude of students towards the sciences and low quality of learning and teaching support materials as challenges facing science teachers in the laboratory. Principal A and Principal B indicated that time frames were unmanageable and unrealistic, and that inadequate teacher orientation and training to limit transfer of learning into classroom practice.

These findings corroborated with the study done by Psillos & Niedderer (2006: 2-3). Their study revealed the following as some of the factors that affect effective laboratory work in Physical Sciences; poor laboratory practices that are ineffective, most laboratory activities are poorly designed, and planned with regard to the levels of understanding of the learners, such that learners end up manipulating equipment but not manipulating ideas.

4. 5 SUMMARY

The main focus of this chapter was the analysis of data collected from the sampled schools. Data were collected quantitatively through the use of two questionnaires namely: questionnaire A and questionnaire B. In addition, data were also collected qualitatively through the use of semi-structured interview which addressed the opinions and views of respondents about the use of science resource centres and laboratories in science teaching. The interview questions were designed primarily to examine the motive behind the responses given by the teachers and the learners in the questionnaire.

The questionnaire and the interview questions were designed such that they provided answers to the five research questions.

From the analysis of results, it was found that the availability and non-availability of teaching resources and of science laboratories were rated with an average to poor ratings. From the research conducted, it is evident that better laboratory facilities are required in the schools so that more practical lessons can be conducted to improve learner performance.

On teacher evaluation, majority were quite positive of the sociable and friendly attitude by their teachers whom they claimed had good abilities to teach, explain, and furthermore attend to both group and individual learners effectively.

Majority of the respondents emphasised the importance of learner- centred learning, which, they were convinced, would give learners ownership of their own learning, improve the science subject delivery, and improve learner performance.

Finally, the respondents were convinced that the content of Physical Sciences CAPS document permits the use of ICT in teaching the subject. Therefore, ICT must be made part of the daily teaching facility and added that the data-logging and the simulation software programs available currently are compatible with the South African CAPS documents.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter presents the summaries of the findings with reference to the problem statement, research questions, aims, and objectives of the research. The conclusions that have been drawn were based on the findings from the study. Recommendations for improvement of Physical Sciences teaching and learning have been made based on the conclusion.

The study originated from the observations made by the researcher and evidence of underperformance of learners in Physical Sciences at matriculation level in Mthatha high schools.

Literature further established that the low performance of learners in Physical Sciences has been a major concern for the country, despite several interventions such as the periodic review of the Physical Sciences curriculum, coupled with a number of other interventions and learner support programmes to improve the performance of learners in the subject.

This study was undertaken against this background to explore the use of science resource centres and laboratories to improve learner performance in Physical Sciences.

Hence, the following research questions guided the study:

- How do laboratories and science resource centres improve learner performance in Physical Sciences education in Mthatha schools?
- What strategies are employed in teaching Physical Sciences in laboratories and science resource centres to enhance scientific literacy in Mthatha schools?

- What accounts for the falling performance levels of learners in Physical Sciences in Mthatha Schools?
- What is the difference in performance in Physical Sciences between schools with well-equipped science resource centres and laboratories and schools without science resource centres and laboratories?
- What are the educational challenges of using the laboratory and the resource centre in science teaching.

5.2 SUMMARY OF FINDINGS

The study focused on the use of science resource centres and laboratories to improve the performance of learners in Physical Sciences. This section presents the research findings of the study and the responses provided to the research questions from respondents.

In answering the five (5) research questions, data collected using questionnaire and semi-structured interview were quantitatively and qualitatively analysed. The findings have been summarised as follows:

5.2.1 The main research question:

How do laboratories and science resource centres improve learner performance in Physical Sciences education in Mthatha schools?

In general, this study identifies a number of views expressed by the teachers and learners with regards to using the laboratory and the science resource centres in science teaching and learning (Section 4.2.5 and Section 4.4.3.4). The views expressed indicated that science laboratories and resource centres provide opportunities for students to experience scientific phenomenon on a first hand bases. In addition, respondents were of the view that learners perform experiments to expose themselves to laboratory activities (Table 4.1), which promote and create enabling environment for teaching and learning of sciences, and to improve and encourage science learning in schools and making science learning real and practical (section 4.4.3.1).

Findings from literature confirmed these findings above. According to Dalton *et al.* (1997), students learn best by doing. By engaging learners in a variety of learning experiences, they are more likely to gain an in-depth understanding of the scientific concepts (Rochelle *et al*., 2000:79) in the laboratory.

Furthermore, the laboratory provides learners practice in raising and defining important problems. Learners are able to learn the meaning and use of controls in experimentation and gain expert practice in analysing data from problem situations. Therefore, learners are able to test their hypotheses and interpret data (Henry, 1947, as cited by Blosser, 1980). In addition, Blosser made it clear that providing students with variety of practical learning experiences can vary the classroom learning environment and enhance students' motivation and interest to learn science.

Some of the responses from the interviews corresponded with answers from the questionnaire survey, while other new aspects emerged spontaneously from the interviews. This shows the value of triangulating the sources used for data collection. These responses to the main Research Question have indicated the great extent to which science laboratories and resource centres can enhance Physical Science teaching.

5.2.2 Research sub-question 1:

What strategies are employed in teaching Physical Sciences in laboratories and science resource centres to enhance scientific literacy in Mthatha schools?

This research found that;

- the teachers and the learners engaged in practical activities, which focused on demonstration and learners are encouraged to work in groups (section 4.2.6).
- learners also engaged in inquiry learning, where they conduct investigation to verify (section 4.3.3)facts.

- the use of ICT in science teaching has overwhelming advantages (section 4.3.4).
- Teachers incorporate theoretical teaching to practical teaching and this enhances the understanding of scientific concepts (section 4.4.3.2 and section 4.4.3.2).

Most teachers unnecessarily mentioned the strategies that are adapted in laboratory and the resource centres in teaching Physical Sciences (Table 4.4). Majority of questionnaire respondents mentioned the use of computer simulations and data-logging.

Hence, literature confirmed these views and indicated that, teaching science requires learners to have hands-on, minds-on experience in experimenting (Fogle, 1985). In addition, the most important features of effective science teaching and learning are laboratory activities that enable learners to take part in the actual teaching and learning process (Thomas: 1972, White & Tisher: 1986). Furthermore, the use of ICT has the potential to support education across the curriculum and provides opportunity for teachers and learners to communication effectively (Dawes 2001). In addition, Kipnis and Hofstein (2007) and Patric and Urhievwejire (2012) were of the view that engaging learners in inquiry learning is effective to promote active participation, meaningful learning, retention in learning, conceptual understanding and learning performance, as well as improving learners' attitudes towards learning science (Deters, 2005).

5.2.3 Research sub-question 2:

What accounts for the falling performance levels of learners in Physical Science sin Mthatha Schools?

The findings pertaining to what accounts for the falling performance levels of learners in Physical Sciences revealed the following categories:

- Learners' attitude towards the subject (2.5.2);
- Poor attendance to school (4.3.1);
- Poor understanding of scientific concepts due to inadequate science resources used in science teaching (4.3.2);
- Learners not able to revise and practice science at home;
- The schools' lack of innovative and readiness to support teaching and learning of Physical Sciences (4.3.3.3);
- Lack of appropriate teaching methodologies (4.2.3);
- Lack of content knowledge of science educators (4.2.3);
- Language barrier (4.3.2);
- Lack of commitment on the part of teachers to assist learners to work extra hard (4.3.3.3);
- Learner - teacher ratio which is non-proportional; and
- Lacks of school-based science laboratories and resource centres (section 4.4.3.3), were identified as factors that lead to low performance in science among learners.

These findings revealed from the data corroborated with the literature reviewed. According to Hughes and Chen (2011), attitudes influence behaviours and behaviours in turn influence conduct and performance. Supportive and positive relationships between teachers and learners ultimately promote a sense of school belonging and encourage learners to actively participate in laboratory activities (Hughes & Chen, 2011:278). However, a situation where learners are not supported by teachers discourages learners from participating actively in the lesson and that influences performance.

Furthermore, lack of resources results in a situation where teachers resort to traditional teaching methodology (Meier, 2003:232). Hence, learners are forced to memorise experiments than experimenting themselves. Nevertheless, Naidoo and Lewin (1998:72) reviewed that learner performance is not solely dependent on the availability of resources but also on the effective use of the available resources by the teachers for learners to understand, hence, Physical Sciences concepts become more difficult for learners to learn. In view of this, the subject remains at a very theoretical level without any experiments to enhance the understanding and application of knowledge (Makgato & Mji, 2006:254).

5.2.4 Research sub-question 3*:*

> *"What is the difference in performance in Physical Sciences between schools with well-equipped science resource centres and laboratories and schools without science resource centres and laboratories*?"

The study found that schools with well-equipped science laboratories perform far better than the schools without science laboratories and science resource centres as rated by the majority (see section 4.4.3.3).

Literature reports that, by using resources and by seeing teachers demonstrating or conducting experiments themselves, learners supplement what is in textbooks and thereby enhance learning (Mji & Makgato, 2006). An advantage is that it helps improve learners' higher order learning skills such as analysis, problem solving, and evaluation and hence, benefits students by supplementing the learning process (Mji & Makgato, 2006) thereby improving performance.

5.2.5 Research sub-question 4:

> *What are the educational challenges of using the laboratory and the resource centre in science teaching?*

In general, this study identified a number of challenges and obstacles that teachers and students face when using the laboratory and the resource centre in teaching and learning.

The findings show:

- lack of resources or inadequate apparatus (4.2.3);
- limited time allocated to Physical Sciences for experimental work (4.2.4); lack of knowledge on ICT use in science teaching (Table 4.6);
- overcrowding during practical activities (4.4.3.5);
- many preparations need to be done by the teacher before performing an experiment with the learners due to absence of laboratory assistance; and
- practical activities are often seen as isolated exercises, bearing little or no relationship with earlier or future work.

It was also revealed that teachers were not doing enough practical activities with the learners because the subject content was demanding. Hence, the focus is shifted on completing the syllabus, instead of wasting time in the laboratory. In addition, teachers complained about the chaos caused by learners, such as, learners not following instructions, inability of teachers to improvise and the difficulty faced by teachers when operating some laboratory equipment, like the ticker timer.

Therefore, these findings confirmed what literature reviewed (section 2.5).

Literature revealed that the level of learning in the laboratory is limited to the curriculum, and that learners do not understand the aims and objectives of doing practical work and are not sure of what the outcome of their activities might be and how they will apply the outcomes in learning (McGarvey 2004:17). In addition, Nakhleh, Polles, and Malina (2002:61) argued that the traditional method of doing practical work where learners resort to following lay down laboratory procedures often leaves little room for creativity or contextualisation.

Furthermore, in a study done by Psillos and Niedderer (2006: 2-3), the following were revealed as some of the factors that affect effective laboratory work in Physical Sciences: poor laboratory practices that are ineffective; and most laboratory activities are poorly designed and planned with regard to the levels of understanding of the learners, such that learners end up manipulating equipment but not manipulating ideas. A study by Muwanga -Zake (2005) confirmed that, most teachers do not engage their learners in practical activities in the laboratory due to their inability to operate on available Physical Sciences equipment like the ticker tape timer (section 2.5.5).

The findings of this study taken together established a compelling relationship between the availability and use of science resources and performance in Physical Sciences. These findings have indicated that Physical Sciences performance gaps in South African schools are a function of use of available resources in the laboratory in science teaching. Hence, the research achieved its intended aims and objectives. The results have revealed observations that confirmed previous research study findings. The research findings have also highlighted observations that require further exploration into the use of science resource centres and laboratories.

5.3 APPLICATION OF FINDINGS

This study can help school leadership to develop strategies for acquiring science resources and ICT facilities that will work best for their individual schools, and can help teachers to become more directly involved in their own teaching. The findings can also help school authorities in the implementation of CAPS Curriculum in Physical Sciences teaching which requires the use of resources and experimentation in teaching science. In addition, the study provides information that can help teachers integrate laboratory activities into their classroom science teaching.

5.4 CONCLUSION

The study focused on the use of science resource centres and laboratories to improve Physical Sciences education.

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The literature provided the purpose for doing this study and was used to form a theoretical framework for understanding the use of science laboratories and science resource centres. The literature reviewed revealed that most researchers and scholars considered the use of science resources in teaching and learning to have an influence in improving the performance of learners in Physical Science. However, it became apparent that there are many variables that account for learner performance in Physical Sciences, and the use of resources in science teaching is just one of them.

As a result, from the literature reviewed, the results obtained from the data and the researcher's observation indicated without a shadow of doubt that resources have an important role in learner performance in Physical Sciences. This is evident in the South African context when comparing former model C schools with other public schools, especially, rural high schools.

From the data, it was revealed that most schools do not use science resource centres and laboratory activities in the teaching of science, despite the benefits science learners derive from these activities. In addition, Physical Sciences teachers identified a number of challenges with the use of the laboratory, namely: overcrowding during practical activities; lack of resources; lack of materials; and apparatus and equipment for Physical Sciences activities, language barrier, limited time allocated to Physical Sciences, lack of knowledge of subject matter and lack of ICT facilities in their schools and the district.

Finally, besides the knowledge of diverse teaching methodologies applicable to Physical Sciences teaching, most teachers rarely use demonstrations and learner-centred teaching. Teachers also need professional development through in-service training, attending workshops to upgrade their knowledge and competencies, and receive training on operation of certain apparatus used in the laboratory.

5.4.1 Concluding remarks

The study focused on the use of science resources and laboratories to improve Physical Sciences education. Hence, the findings of this research contribute to literature in three ways as indicated in section 1.5 of Chapter One:

Firstly, it provides evidence that the use of science laboratory and resource centre activities, together with a more learner-centred approach to teaching would significantly improve learner performance in Physical Sciences. This is an immediate goal relating to the current performance of learners in Physical Sciences education.

Secondly, it provides a review of the constructivist instructional method of Physical Sciences teaching and learning in relation to the use of resources. Hence, teachers need to have the confidence and willingness to change and accommodate changes and challenges of the modern ways of teaching science. In addition, teachers are required to assist learners to be independent inquirers and thinkers, and not always rely on the teacher. Moreover, teachers also require opportunities for professional development and cooperation from colleague science teachers, at all levels to develop professionally. Furthermore, there is the need for more research to be done, with emphasis on classroom-based science teaching in the South African context.

Lastly, the study has relevance to science education across South Africa and the continent at large. Hence, the researcher is of the view that Physical Sciences teachers should make use of the laboratory and the science resource centre in teaching the subject, since literature revealed that science resources used in teaching has the potential to make abstract and imaginary concepts real.

Moreover, the findings provided information that can help teachers integrate practical teaching into their theoretical teaching in the laboratory. The findings, conclusions, and recommendations should help school authorities in the alleviation of identified barriers and in the planning and management of professional development programmes. If such structures are put in place, the approaches to teaching science should contribute to a more conducive learning environment for teaching and learning.

5.5 RECOMMENDATIONS

The following recommendations and suggestions were made from the study to bring about a greater positive impact for Physical Sciences teachers and science learners in the use of the science resource centres and laboratories to improve learner performance in the subject.

Recommendation 1

Lack of resources sometimes frustrates both educators and learners, hence learners might develop a negative attitude towards the sciences, and thus few learners might opt out for these sciences in Grades 10 to 12. The department must make provision of basic resources for teaching Physical Science to all high schools. This will make science more accessible.

Recommendation 2

All registered secondary schools in Mthatha should be provided with laboratories and basic laboratory equipment and apparatus to lessen stress on the science resource centres and to reduce the risk of travelling over long distances to the resource centres. Private schools should also be compelled to equip their schools adequately with science resources before allowing them to register their schools for Physical Sciences courses.

Recommendation 3

The activities organised at the science resource centres should be expanded to integrate junior secondary school science into the programme. This would motivate learners at tender ages to develop interest in Physical Sciences.

Recommendation 4

Computer programmes can be designed and used for teaching scientific investigations and cater for resources that cannot be easily accessible for most learners in class. In schools where resources are not readily available and classes are overcrowded, computer simulations can be used.

Recommendation 5

Regular in-service training should be organised for Physical Sciences teachers in the science resource centres. These training programmes would keep teachers up to date with current developments in the scientific world. During these sessions, teachers meet to discuss issues of common interest and brainstorm to find solutions to challenges they face as teachers in their various schools.

Recommendation 6

There should be regular monitoring of the laboratories in schools by personnel from the Department of Basic Education. In this way, problems faced in the laboratories would be known and addressed accordingly. It would also be a way of ensuring that the aims and objectives of the establishment of the laboratories and the resource centres have been achieved.

Recommendation 7

The Department of Basic Education should also conduct audits in the various schools to identify the availability and non-availability of resources in schools. This will ensure that the provision of science resources in all schools across South Africa is standardised.

5.6 SUGGESTIONS FOR FURTHER STUDIES

This study could only look at seven (7) high schools in Mthatha and their perception and opinions about the use of science laboratories and resource centres in Physical Sciences teaching to improve learner performance in Physical Sciences. Further studies could be done in the other schools' science laboratories and resource centres in the Mthatha Education District, other Districts, Eastern Cape Province, as well as the other eight (8) provinces to get the right picture of what is happening at the science resource centres and the laboratories across South Africa.

More research is needed on the role that teachers should play during Physical Sciences laboratory work and how they could positively contribute to harmonious laboratory learning environment.

It is absolutely necessary to note that these recommendations for further research can never be complete or exhaustive in nature, but they simply indicate possible directions for further research.

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LIST OF APPENDICES

APPENDIX A

Sakyiwaa Danso

C/o. Dr. P.J.Heeralal

University of South Africa

UNISA, Pretoria.

15th May, 2014

The District Director

Department of Education

P/Bag x5003

Mthatha.

5099

Dear Sir/Madam,

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN PUBLIC HIGH SCHOOLS AND PRIVATE HIGH SCHOOLS IN MTHATHA IN FULFILMENT OF THE REQUIREMENTS FOR A MASTERS DEGREE IN EDUCATION(NATURAL SCIENCE) WITH UNISA.

I am a Physical science and Life science teacher at Mpindweni Senior Secondary School in the Mthatha Education District.

I am currently registered as a Master of Education (Natural Science) student under the supervision of Dr. P.J. Heraalal in the Department of Education Studies at Unisa.

As part of my studies I am required to undertake research in fulfilment of the requirements for attaining my degree. The title of my research is “*The use of science resources and laboratories to improve physical science education in Mthatha.*”

The purpose of the study is to investigate and analyse how physical science teachers use science resources in teaching and learning of physical science in order to suggest ways of improving the teaching and learning of physical science.

In order to do so, principals, physical science teachers and physical science learners in Grade 11 and 12 in public high schools and private high schools in Mthatha need to complete the questionnaire and be interviewed . I therefore would like to humbly request for your permission to conduct the research in public and private high schools in Mthatha. These schools include; Umtata high school, St John’s College, Zingiza Comprehensive high school, Ngangelizwe high school, Ikwezi technical skills centre, St. Martins high school and Kings Commercial College.

Participation by respondents will be voluntary. Anonymity and confidentiality will be assured to all participants. Furthermore, the research processes will not disrupt any lessons or any scheduled activities of the schools. A written approval to be used as a letter of introduction to the targeted schools would be appreciated. Please do not hesitate to contact me if you have any further queries or clarifications.

I look forward to your anticipated positive response.

Thank you.

Yours faithfully,

……………………….

Danso Sakyiwaa. Student no: 45257574

Email: 45257574@mylife.unisa.ac.za Cell no: 0737586444.

Appendix B

Province of the
EASTERN CAPE
EDUCATION

Human Resource Planning & Provisioning Services

Botha Sigcau Building, Corner of Owen and Leeds Street, Mthatha, 5099, Private Bag x 5003, Mthatha 5099 REPUBLIC OF SOUTH AFRICA Website www.ecdoe.gov.za: Email: zifiks @webmail. co.za

Tel : 047 5024226 **Fax: 047 5313536**

Enquiries: Mr Ndamase

THE HEAD
FACULTY OF EDUCATION
UNIVERSITY OF SOUTH AFRICA
PRETORIA

RE : PERMISSION TO CONDUCT STUDY : MISS DANSO SAKYIWAA PERSAL NO. 54765315

This communique serves to grant Miss Danso permission to conduct the study in the schools you listed in your letter of request. This office hopes that the findings of the study will be of benefit to the District at large.

Thanking you in advance for your cooperation in this matter

Yours in Education

....
District Director : Mthatha District

ISEBE LEMFUNDO NENCUBEKO
IPHONDO LEMPUMA KOLONI
DEPARTMENT OF EDUCATION
HRA & PLANNING

DATE: 16/5/014

PROVINCE OF THE EASTERN CAPE
DEPARTMENT VAN ONDERWAS
OOP KAAP PROVINCE

APPENDIX C

Research topic: The use of science resource centres and laboratories to improve physical science education in Mthatha

Researcher: Miss Sakyiwaa Danso

Dear Principal,

My name is Sakyiwaa Danso. I am a student at the university of South Africa and currently enrolled for the master's degree by dissertation in education, with specialisation in Natural Science Education. Dr.P.J. Heeralal is my supervisor for the dissertation. I am also a physical science teacher at Mpindweni Senior Secondary School in Mthatha district. As a requirement for my degree, I am to conduct a research study which examines "*The use of science resource centres and laboratories to improve physical science education in Mthatha"*, I have selected your school as a research site to collect data for the study.

The purpose of this study is to establish the use of science resources in the teaching and learning process by examining the views and perceptions of physical science learners and science teachers on the use of science resources in the teaching learning process. In order to do so, I wish to administer a questionnaire to 13 physical science learners and their science teacher to answer and then be interviewed. This questionnaire and interview will take approximately one hour. The questionnaire for the teacher contains thirty one (31) items and thirteen (13) items for the learners. The findings of this study will help to find pedagogical way of teaching in order to improve the performance of learners in physical science.

I would therefore like to request the participation of your school in this study by allowing me to conduct the study in your school. The researcher will like to meet with the physical science teacher to determine the schedule for administering the questionnaire and conducting the interview. Preferably, during the time of the day when learners have a practical activity in the science laboratory. The school will be given the opportunity to receive a summary of the findings. The researcher will not use the names of learners or teacher and even the name of the school in the study. The information that will be given by learners and the teacher will remain confidential. Learners and teachers may withdraw from the study at any time even after they have consented to participate. All recordings for the study will be destroyed after the research has been presented to the university and that will take up to five years after collecting data. Participants will not be exposed to any danger or risk by participating in this study.

In addition, the study has been approved by the Eastern Cape Department of Education, Mthatha district education office. Please, find attached a copy of the letter of approval from the departmental office.

Please, do not hesitate to contact me if you would like to know more about the study.

Thank you for your cooperation and assistance.

Yours faithfully,

…………………………… email:bettydanso@yahoo.com

Ms.Sakyiwaa Danso cell: 0737586444

APPENDIX D

Dear Ms Danso,

I,…………………………………………………………………………………………………….the principal of ……………………………………………………………high/secondary school, acknowledge that I have received, read and understood the content of the request letter that you sent me to explain your intentions to conduct research in my school. The title of your research is; *The use of science resource centres and laboratories to improve physical science education in Mthatha.* The purpose of the study is also well explained in your letter of request.

I therefore **give consent/do not give consent** that my school; the teachers and specific group of learners will take part in your study.

Principal signature: …………………………………………………

Date: …………………………………………………

Researcher signature: …………………………………………………

Date: ………………………………………………..

APPENDIX E

Research topic: The use of science resource centres and laboratories to improve physical science education in Mthatha.

Researcher: Ms Sakyiwaa Danso

Dear grade 11 and 12 physical science teacher,

My name is Sakyiwaa Danso. I am a student at the University of South Africa and currently enrolled for the master of education degree with specialisation in Natural science by dissertation. The supervisor for the dissertation is Dr. P.J.Heeralal. I am also a physical science teacher at Mpindweni senior secondary school. As a requirement for the award of the degree, I am conducting a research which examines "*The use of science resource centres and laboratories to improve physical science education in Mthatha"*. Your school has been selected for the study and your Grade 11 and 12 learners will be involved in the study.

The main purpose of the study is to establish learners' views and perceptions about science laboratory activities and the use of resources in the teaching and learning of physical science. In order to do this, I wish to administer questionnaires to thirteen of your physical science learners in Grade 11 and 12, and also to conduct interview to established rapport between the researcher and the learners.

I would like to humbly request you to be part of this study. If you agree to participate, you will be expected to assist the researcher to administer the questionnaire to the learners and also respond to your own questionnaire and be interviewed by the researcher. In any case, participation in this research is voluntary and there will be no victimization whatsoever for refusal to participate. There will be no interruption of your normal school programme. The data collected will be treated with confidentiality and the names of your school, yourself and your learners will not be divulged. You are allowed to change your mind at any time, and withdraw during the course of the research. You and your learners will not be exposed to any form of injury or risks for participating in this study.

If you agree to participate, I will contact the parents of the learners in your class to request their approval and permission for their children to participate in the study. In addition, each learner will receive assent form. Learners will also be allowed to choose if they want to participate in the research or not to participate.

A letter of approval of this research has been received from the Mthatha Department of Education. Please, find attached a copy of the letter of approval from the department of education, Mthatha district office.

Please, do not hesitate to contact me for further information and queries.

Thank you for your cooperation and assistance.

Yours Faithfully,

……………………………… email: 45257574@mylife.unisa.ac.za

Ms Sakyiwaa Danso cell: 0737586444

APPENDIX F

Dear Ms Danso,

I, ……………………………………………………………………………………………………..the teacher for Grade 11 and 12 physical science at…………………………………………………high/secondary school, acknowledge that I have received, read and understood the content of the request letter that you sent me to explain your intentions to conduct research in my classroom. The title of your research is*: The use of science resource centres and laboratories to improve physical science education in Mthatha*, and the purpose of the research is explained in the letter.

I therefore **give consent/do not give consent** to participate in your research.

Teacher signature:…………………………………………………

Date: ………………………………………………….

Researcher's signature:………………………………………..

Date: ………………………………………….

APPENDIX G

Research topic: The use of science resource centres and laboratories to improve physical science education in Mthatha.

Researcher: Ms Sakyiwaa Danso

Dear parent/guardian,

My name is Sakyiwaa Danso. I am a student at the University of South Africa and currently enrolled for the master of education degree with specialisation in Natural science by dissertation. The supervisor for the dissertation is Dr. P.J.Heeralal. I am also a physical science teacher at Mpindweni senior secondary school. As a requirement for the award of the degree, I am conducting a research which examines *The use of science resource centres and laboratories to improve physical science education in Mthatha."* Your child has been selected as one of the participants for the study.

The main purpose of the study is to establish learners' views and perceptions about science laboratory activities and the use of resources in the teaching and learning of physical science. In order to do this, I wish to administer questionnaires to thirteen physical science learners in Grade 11 and 12, and also to conduct interview to established rapport between the researcher and your child. Therefore, your child will be interviewed and will be given questionnaire to respond to during the second term of the 2014 academic year. The questionnaires to respond to and the interviews to be conducted will take approximately one hour in your child's school.

I would therefore request the participation of your child in this research. The result of this study will remain confidential and anonymous and will assist physical science teachers to adapt teaching methods and resources that will help learners improve their performance in physical science. Learners will not be exposed to any form of injuries or risks. Participation in this research is also voluntary and there will be no negative consequences whatsoever for refusal to participate.

There will be no interruption of your child's normal school programme. The school's time table will be followed. Data collected will be treated with confidentiality and the name of your child will not be mentioned in the analysis of the data. That is, the name and the identity of your child will be protected in this study. Please indicate on the attached form whether you permit your child to take part in this study.

Please, do not hesitate to contact me if you have any queries.

Thank you for your cooperation and assistance.

Yours sincerely,

…………………..   .Cell: 0737586444

Ms.Sakyiwaa Danso   .email: 45257574@mylife.unisa.ac.za

APPENDIX H

Dear Ms Danso,

I,……………………………………………………………………………………………………..,the parent/guardian of ,……………………………………………………………………., acknowledge that I have received, read and understood the content of the request that you sent me to explain your intention to allow my child to participate in your research. The title of your research is*: "The use of science resource centres and laboratories to improve physical science education in Mthatha*," and the purpose of the research is explained in the letter.

I therefore **give consent/do not give consent** for my child to participate in your research.

Parent signature: ………………………………………………………

Date: ………………………………………………………

Researcher signature: …………………………………………………….

Date: …………………………………………………..

APPENDIX I

Research topic: The use of science resource centres and laboratories to improve physical science

Education in Mthatha.

<u>Researcher</u>: Ms Sakyiwaa Danso

Dear learner,

My name is Sakyiwaa Danso. I am a student at the University of South Africa and am currently enrolled for the Master of Education degree in Natural Science by dissertation. As a requirement for the award of this degree, I have to become acquainted with aspects of doing research that will involve Grade 11 and 12 physical science learners in your school. My study focuses on investigating the effective use of science resources in teaching and learning of physical science. The title of the research is *" The use of science resource centres and laboratories to improve physical science education in Mthatha*. The supervisor for this research is Dr. P.J.Heeralal who is a Senior Lecturer at the Department of Science and Technology education

The main purpose of this research is to establish suitable teaching and learning methods that utilise effective use of science resources in the teaching and learning process in order to improve learner performance in physical science. The study findings will be available to you and your school and will be shared by various stakeholders including the policy makers and the education providers. It will also benefit the science teachers by drawing their attention to the importance of using teaching resources to improve their instructional programmes. I therefore, wish to invite you to participate in this research.

Participation is voluntary and your responses will remain confidential, your identity and that of your school will not be revealed. Permission letter will be sent to your parents asking them to grant you permission to participate in this study. You may withdraw from participating at any stage of the research. The research processes will not disrupt any lessons or any scheduled activities in the school and will be conducted between 14hours and 15hours. Before conducting the interview and administering the questionnaire, the researcher will convene a meeting with all participants to explain the significance of the study and clarify any issues relating to the study. Please, complete the attached assent form and return it to the researcher.

Please, do not hesitate to contact me if you have any queries or further information about this research.

Thank you for your cooperation and assistance.

Yours sincerely,

………………………………

Ms Sakyiwaa Danso

Email: 45257574@mylife.unisa.ac.za

Cell" 0737586444

APPENDIX J

Dear Ms Danso,

After reading and understanding the content of the request letter given to me by the researcher; Ms Sakyiwaa Danso, I……………………………………………………, the learner in Grade 11/12 physical science class, **agree/do not agree** to participant in this research in which the researcher will investigate the use of science resource centres and laboratories to improve physical science education in Mthatha.

My decision on the research activities is as follows:

- I will **respond/not respond** to the questionnaires to be given to me.
- I will **avail/not avail** myself for the interview.

Learner signature: ……………………………………………

Date: ……… ……………………………………

Researcher signature: ……………………………………..

Date: ……………………………………..

UNISA university of south africa

2020

DANSO S MISS
NO 12 NQADU ROAD
HILLCREST
5100

STUDENT NUMBER : 4525-757-4

ENQUIRIES TEL : 0861670411
FAX : (012)429-4150
eMAIL : mandd@unisa.ac.za

2014-03-05

Dear Student

I hereby confirm that you have been registered for the current academic year as follows:

Proposed Qualification: MED (SP IN NATURAL SC EDU) (98448)

CODE	PAPER	S	NAME OF STUDY UNIT	WEIGHT	LANG.	PROVISIONAL EXAM.DATE	EXAMINATION CENTRE(PLACE)
Study units registered without formal exams:							
DFNSE95			MED - NATURAL SCIENCE EDUCATION (DISSERTATION)	0.470	E		

You are referred to the "MyRegistration" brochure regarding fees that are forfeited on cancellation of any study units.

CREDIT BALANCE ON STUDY ACCOUNT: 130.00-

Yours faithfully,

Prof M Mosimege
Registrar

0108 0 00 0

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
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APPENDIX L 1

SEMI-STRUCTURED INTERVIEW QUESTIONS

PART 1: SEMI-STRUCTURED INTERVIEW FOR THE PRINCIPALS

Theme 1: the use of science laboratory and the resource centre to improve learner performance

1.1 What is your understanding of a science resource centre and a science laboratory?

1.2 Why were sciences laboratories proposed and established in schools?

1.3 How has the South African government placed physical science education in the national educational agenda?

1.4 In your view, what can be done by the schools to improve the performance of learners in physical science?

Theme 2: strategies that are employed in teaching science in the laboratory and resource centre

2.1 What strategies are employed in teaching physical science in laboratories and science resource centres to enhance scientific literacy in Mthatha schools?

Theme 3: what account for the falling performance levels of learners in science?

3.1. What accounts for the falling performance levels of learners in physical science in Mthatha Schools?

Theme 4: the educational benefit of using the laboratory and the science resource centre

4.1 What roles do we see for science resource centres in the teaching and learning of physical science in the South African educational system?

Theme 5: Educational challenges of using the science laboratory and resource centre.

5.1 What challenges are faced by science teachers when it comes to the implementation of curriculum and why?

APPENDIX L $_2$

PART 2: SEMI- STRUCTURED INTERVIEW FOR SCIENCE TEACHERS

Theme 1: the use of science laboratory and the resource centre to improve learner performance

1.1 What is your understanding of a science resource centre and a science laboratory?

1.2 What are the key science resources that have been identified procured and distributed to either schools or district science resource centres?

1.3 Are these resources used regularly by teachers and learners to improve the quality of teaching and learning of physical science?

1.4 What is the difference in performance in physical science between schools with well-equipped science laboratories and schools without science laboratories?

Theme 2: strategies that are employed in teaching science in the laboratory and resource centre

2.1 What educational initiatives can be embarked upon to enhance students learning of physical science?

2.2 What in your opinion should be done to help improve the performance of learners in physical science?

2.3 Do the availability/non availability of science resources affect the teaching strategies used?

2.4 How do you as a teacher incorporate your theoretical lessons into your practical lessons?

3. Theme 3: what account for the falling performance levels of learners in science.

3.1 How do we account for the poor performance of some learners in physical science subject?

Theme 4: the educational benefit of using the laboratory and the science resource centre

4.1 What contributions do science resource centres bring to enhancing students' performance in science?

4.2 What are the educational benefits from using laboratories in physical science education?

Theme 5: Educational challenges of using the science laboratory and resource centre

5.1 What are the educational challenges of using laboratories in physical science education?

5.2 Do you experience any problems when it comes to conducting practical lessons?

5.3 As a teacher, do you think you are doing enough practical work according to the syllabi demand?

APPENDIX L $_3$

PART 3: SEMI-STRUCTURED INTERVIEW FOR PHYSICAL SCIENCE LEARNERS IN GRADE 11/12.

Theme 1: the use of science laboratory and the resource centre to improve learner performance

1.1 What in your opinion as a learner can be done to improve learner performance in Physical Sciences?

1.2 Does your science teacher use science resources in his/her teaching of physical science concepts?

1.3 Does your school provide you with the required text books and study guide for studying physical science?

1.4 In your daily class lessons, are you able to assist your friends and vice versa thereby helping to improve your understanding of science concepts?

Theme 2: strategies that are employed in teaching science in the laboratory and resource centre

2.1 Do you engage in practical activities at school for Physical Science? If so, does it help to improve your understanding of the subject?

2.2 Are you sometimes allowed by the teacher to come out with your own topics or projects to investigate?

2.3 Are your practical investigations related to your theoretical topics and if not what type of topics do you do in your practical work.

2.4 Does your teacher encourage you to do group work during practical lessons? If so how does he/she do it?

Theme 4: the educational benefit of using the laboratory and the science resource centre

4.1 Do you find practical work to be exciting and thought provoking?

5: Theme 5: what are the educational challenges of using the science laboratory and resource centre

5.1 What are some of the major difficulties you as a grade 11/12 learner experience with Physical Science?

APPENDIX M

QUESTIONNAIRE A: QUESTIONNAIRE FOR GRADE 11 AND 12 PHYSICAL SCIENCE TEACHERS

(a) Please respond to each of the following questions.

(b) Please read all the questions thoroughly and indicate your answer by placing an **X** in one box only.

(c) Answer all questions.

(d) Your responses will be treated as confidential, so please be honest.

SECTION A: BIOGRAPHICAL DATA

1. What is your gender?

Male	1	V_1
female	2	

2. Please indicate years of experience in the teaching of Physical Sciences in Grades 10, 11 and 12.

0 – 5 years	1	V_2
6 – 10 years	2	
11 – 15 years	3	
16 – and more years	4	

3. Please indicate the highest qualification you obtained in science at high school.

Grade 12 science at standard grade	1	V_3
Grade 12 science at high school	2	
GCE ‘O’ level Cambridge science	3	
GCE ‘A’ Level Cambridge science	4	
Did not do science at high school	5	
Others (please specify)………………	6	

4. What is your highest qualification in teaching Physical Science?

Teacher’s certificate	1	V_4
Diploma in Education	2	
Advanced Certificate in Education(ACE)	3	
Bachelor of Education Degree(BED)	4	
Post Graduate Certificate in Education(PGCE)	5	
Honours Bachelor of Education degree	6	

Master of Education degree	7	
Doctor of Education degree	8	
Others (please specify)…………..	9	

5. What was your major subject(s) during your training as a teacher?

Physical Sciences only	1	V_5
Mathematics only	2	
Both Physical Sciences and Mathematics	3	
Physical Sciences and other subjects	4	

SECTION B: RESOURCES AVAILABLE FOR SCIENCE TEACHING

6. Which of the following do you use when teaching Physical Science?

Classroom	1	V_6
Laboratory	2	
Resource centre	3	
Classroom and laboratory for experimentation	4	

7. Do you have access to the school's science laboratory and a science resource centre?

Yes	1	V_7
No	2	

8. Please indicate the adequacy of the following resources in your science department by placing an X in the appropriate box according to the following meanings of the numbers.

Very poor	1
Poor	2
Average	3
Good	4
Very good	5

Materials/apparatus/resources	1	2	3	4	5	
8.1 Reagents and apparatus for chemistry practical.						V_8
8.2 Equipments for physics practical.						V_9
8.3 Stools/chairs for science learners to sit on and learn.						V_{10}
8.4 Benches for science learners to do experiment/ write out their observations.						V_{11}
8.5 Science textbooks for reference.						V_{12}

8.6 White boards.						V_{13}
8.7 computers.						V_{14}
8.8 Data projectors.						V_{15}
8.9 Scientific models.						V_{16}
8.10 Scientific wall charts.						V_{17}
8.11 CAPS documents.						V_{18}
8.12 Learner support materials.						V_{19}

SECTION C: KNOWLEDGE OF CONTENT OF SUBJECT MATTER

9. Which aspect of Physical Sciences do you find difficult to teach?

Chemistry	1	V_{20}
Physics	2	
Both chemistry and physics	3	
none	4	

10. Please indicate your knowledge of content of the subject matter as a science educator by placing an X in the appropriate box:

Very poor	1
Poor	2
Average	3
Good	4
Very good	5

Knowledge of subject matter	1	2	3	4	5	
10.1 In-depth Knowledge of content.						V_{21}
10.2 Ability to answer questions asked by learners.						V_{22}
10.3 Confident in handling all topics in Physical Sciences.						V_{23}
10.4 Knowledge of curriculum terminologies.						V_{24}
10.5 Knowledge of CAPS principles and policies.						V_{25}

SECTION D: TEACHING AND LEARNING

11. Indicate whether you are currently teaching physical science only or with other subjects.

Physical Sciences only.	1	V_{26}
Physical Sciences and (other subject(s) …………………………..	2	

12. Indicate how many learners are in your Physical Sciences class?

30 or less.	1	V_{27}
31 to 45 learners.	2	
46 to 100 or more.	3	

13. How do you cope with the large number of learners you teach?

Very difficult to cope	1	V_{28}
Difficult to cope	2	
Easy to cope	3	
Cope very well	4	

14. How many Physical Science periods do you have in total per week?

20 or less periods	1	V_{29}
21 to 30 periods	2	
31 or more periods	3	

15. Please indicate how you cope teaching this number of periods.

Very difficult to cope	1	V_{30}
Difficult to cope	2	
Cope well	3	
Cope very well	4	

16. Please indicate the language(s) you use for teaching in your science class?

English only	1	V_{31}
Home language only	2	
Home language and English combined	3	
Others(specify)	4	

17. How would you rate the general attitude of your science learners towards the subject?

Very negative	1	V_{32}
negative	2	
Positive	4	
Very positive	5	

18. Indicate how often you use teaching and learning materials in your Physical Sciences lessons by placing an X in the appropriate box using the information below.

Never	1	V_{33}
Seldom	2	
often	3	
Very often	4	

TEACHING LEARNING	1	2	3	4	
18.1 Use a variety of teaching materials in my lessons.					V_{34}
18.2. Allow learners to discover the content by varying teaching methods and teaching aids.					V_{35}
18.3. Able to capture learners interest with the use of learning materials					V_{36}
18.4. Make use of different learning activities.					V_{37}

19. How often do you organise extra lessons for Physical Science learners within a term?

Never	1	V_{38}
Seldom	2	
Usually	3	
Always	4	

SECTION E: ORGANISATIONAL SKILLS

20. Please indicate how you would rate your skills in your current position as a science educator by placing an X in the appropriate box according to the following meanings of the numbers.

Very poor	1
Poor	2
Average	3
Good	4
Very good	5

ORGANISATIONAL SKILLS	1	2	3	4	5	
20.1 Lesson preparation.						V_{39}
20.2 Ability to organise materials before an experimental activity.						V_{40}
20.3 Classroom management during a Physical Science lessons.						V_{41}
20.4 Readily use of science resources/equipments during Physical Sciences lessons.						V_{42}
20.5 Recording and filing of all class activities.						V_{43}
20.6 Assessment of learners strengths and weaknesses						V_{44}
20.7 Assessment of the science teacher's own strengths and weaknesses						V_{45}
20.8 Ability to maintaining science equipment/apparatus.						V_{46}

SECTION F: TEACHING PRACTICAL INVESTIGATION AND CONDUCTING EXPERIMENT

21. Please indicate how you teach practical investigation and conduct experiment with your learners by placing an X in the appropriate box according to the following meanings of the numbers.

Never	1
seldom	2
Sometimes	3
Often	4
always	5

TEACHING PRACTICAL INVESTIGATION AND CONDUCTING EXPERIMENT	1	2	3	4	5	
21.1 I derive investigation activities from text books.						V_{47}
21.2 I teach important concepts before learners can do scientific investigations.						V_{48}
21.3 Learners suggest questions and problems for investigation activities.						V_{49}
21.4 I provide learners with different possible questions to be investigated.						V_{50}
21.5 I design scientific investigation activities and guide them on what to do.						V_{51}
21.6 I allow learners to work without my intervention when conducting scientific investigation.						V_{52}
21.7 I supply learners with manuals to follow during scientific investigations.						V_{53}
21.8 I have some difficulty in using some laboratory equipments.						V_{54}
21.9 I conduct experiments with my learners to verify facts taught in class.						V_{55}
21.10 Learners are guided by the teacher during a practical activity						V_{56}

SECTION G: ICT USE IN TEACHING AND LEARNING OF PHYSICAL SCIENCE

22. Please indicate your views about the use of ICT in Physical Sciences education by placing X in the appropriate boxes based on the criteria below. For the purpose of this questionnaire; Information and Communication Technology (ICT) is defined as a range of technologies for gathering, storing, retrieving, processing, analysing, and transmitting information like computers, projectors, and internet. ICT is used in the science resource centres and the science laboratory in the teaching and learning of Physical Sciences.

Strongly disagree	1
disagree	2
Uncertain	3
Agree	4
Strongly agree	5

ICT USE IN THE TEACHING AND LEARNING PROCESS	1	2	3	4	5	
22.1. I do use ICT (computer simulation and data logging) to teach science.						V_{57}
22.2. I have knowledge on the use of ICT in teaching science.						V_{58}
22.3. ICT should always be used in teaching Physical Science.						V_{59}
22.4. Use of ICT should be integrated into traditional normal teaching methods.						V_{60}
22.5. Using ICT in teaching makes teaching a lot more easier.						V_{61}
22.6. Using ICT in teaching Physical Science saves lot of time.						V_{62}
22.7. Using ICT in teaching Physical Science makes diagrams clearer than drawings and illustrations on the chalk board.						V_{63}
22.8. Using ICT in teaching science captures learners' attention in the lesson.						V_{64}
22.9. Using ICT in teaching helps to control the class.						V_{65}
22.10. Using ICT in teaching science brings excitement to learners.						V_{66}
22.11. Using ICT in teaching science makes it easier for learners to visualize lessons.						V_{67}
22.12. Using ICT in teaching makes imaginary concepts (e.g. photoelectric effect) real.						V_{68}

SECTION H: INDIVIDUAL'S OPINIONS ABOUT THE TEACHING AND LEARNING OF PHYSICAL SCIENCE.

23. The statements that follow ask for your opinion about the teaching and learning of physical science in your school. Please indicate your opinion with an X in the appropriate answer box based on the criteria below.

Strongly disagree	1
Disagree	2
Uncertain	3
Agree	4
Strongly agree	5

OPINIONS	1	2	3	4	5	
23.1. I teach Physical Science in grade 12 for examination purposes only.						V_{69}
23.2. I do experiments in science even if these may be dangerous to my learners.						V_{70}
23.3. I do not give my learners chance to perform certain experiments even if it is safe to do so.						V_{71}
23.4. I take responsibility if accidents occur.						V_{72}
23.5. I organise educational field trips for my learners once a year.						V_{73}
23.6. I give my learners a chance to scrutinise their strengths and weaknesses, for remedial work.						V_{74}
23.7. I vary my teaching methods in my lessons.						V_{75}
23.8. I give out homework to my learners to reinforce the lesson taught in the classroom.						V_{76}
23.9. The school timetable permits me to spend more time with weaker learners.						V_{77}
23.10. My head of the science department listens to suggestions from other science educators.						V_{78}
23.11 The way this school is run makes it difficult for science teachers to perform their duties with diligence.						V_{79}
23.12 I am content with my work as a science educator.						V_{80}
23.13 CAPS has too much of paper work.						V_{81}

- Thank you very much for being part of this study. God richly bless you.

APPENDIX N

QUESTIONNAIRE B: QUESTIONNAIRE FOR PHYSICAL SCIENCE LEARNERS IN GRADES 11 AND 12.

INSTRUCTIONS

(a) Please respond to each of the following questions.

(b) Read through all the questions thoroughly and then indicate your answer by placing an X in the appropriate boxes.

(c) Answer all questions.

(d) Your responses will be treated as confidential, so please be honest.

SECTION A: BIOGRAPHICAL DATA

1. Please indicate your grade.

Grade 11	1	V_1
Grade 12	2	

2. What is your gender?

Male	1	V_2
female	2	

3. How old are you?

17 years and younger	1	V_3
18 years	2	
19 years	3	
20 years and older	4	

4. Do you own a scientific calculator to assist you with calculations?

Yes	1	V_4
No	2	

5. How often do you absent yourself from school?

Never	1	V_5
seldom	2	
often	3	

SECTION B: TEACHING AND LEARNING PROCESS

6. What teaching language does your Physical Sciences educator use during the lesson?

English only	1	V_6
Learners home language only	2	
The teachers home language only	3	
English and learners home language combined	4	
Other(please, specify)	5	

7. Do you understand the teaching language used by your educator during the science lesson?

Yes	1	V_7
No	2	

8. What teaching language would you prefer your science educator to use during the lesson?

English	1	V_8
Home language only	2	
English and home language combined	3	
Other(please specify)	4	

9. Do you experience difficulties in reading English, writing English or have numerical difficulties. Please indicate your answers in the appropriate answer boxes.

LANGUAGE AND NUMERICAL DIFFICULTIES	Yes	No	V_9
Difficulties in reading English			
Difficulties in writing English			
Numerical difficulties			

10. How would you rate your Physical Sciences educator on each of the following traits? Please indicate by placing an **X** in the appropriate box based on the following criteria.

Very poor	1
Poor	2
Fair	3
Good	4
Very good	5

TRAIT	1	2	3	4	5	
10.1. Sociable and friendly towards science learners						V_{10}
10.2. Ability to assist science learners						V_{11}
10.3. Ability to explain clearly during the lesson						V_{12}
10.4. Ability to inspire science learners						V_{13}

SECTION C: INDIVIDUALS' OPINIONS

11. The statements that follow ask for your views about your school and the teaching and learning activities in your Physical Sciences lesson. Please indicate your views by placing an **X** in the appropriate boxes based on the criteria below.

Strongly disagree	1
disagree	2
Uncertain	3
Agree	4
Strongly agree	5

OPINIONS	1	2	3	4	5	
11.1 I am always excited during Physical Sciences lessons.						V_{14}
11.2 Science lessons are interested enough to keep me attentive.						V_{15}
11.3 My science teacher spends enough time on each individual topic.						V_{16}
11.4 My science teacher is always concerned about our understanding of each topic.						V_{17}
11.5 We have done many experiments in Physical Sciences with our teacher this year.						V_{18}
11.6 We are always given the opportunity to perform experiments individually.						V_{19}
11.7 We are able to discover scientific concepts all by ourselves.						V_{20}
11.8 I see Physical Sciences subject as too abstract.						V_{21}
11.9 I see Physical Sciences as related more to the environment.						V_{22}
11.10 I understand most of the science concepts we have encountered in the lessons						V_{23}
11.11 I am given the opportunity to ask questions during the science lessons						V_{24}
11.12 All learners are treated fairly by the Physical Sciences teacher.						V_{25}
11.13 The science teacher provides support to all learners during science lessons.						V_{26}
11.14 The science teacher is always punctual to class.						V_{27}

11.15 We are always given homework						V_{28}

SECTION D: THE USE OF ICT IN TEACHING AND LEARNING PHYSICAL SCIENCES

12. Please indicate your views about ICT use in teaching and learning of science, using the following indicators and placing **X** in the appropriate box.

Strongly disagree	1
Disagree	2
Uncertain	3
Agree	4
Strongly agree	5

USES OF ICT IN THE TEACHING AND LEARNING OF PHYSICAL SCIENCES	1	2	3	4	5	
12.1. The teacher uses ICT (computer simulation) to teach						V_{29}
12.2. Teachers should be trained on the use of ICT in teaching						V_{30}
12.3. ICT should always be used in teaching Physics topics						V_{31}
12.4. ICT usage should be integrated with traditional normal teaching methods						V_{32}
12.5. ICT usage makes teaching Physics easier						V_{33}
12.6. ICT usage saves time used in drawing and labelling diagrams on chalk board						V_{34}
12.7. ICT usage makes diagrams clearer than drawing them on the chalk board.						V_{35}
12.8. ICT usage captures learners' attention in class.						V_{36}
12.9. ICT usage helps class control						V_{37}
12.10. ICT usage brings excitement in learners.						V_{38}
12.11. ICT usage makes it easier for learners to visualize lessons						V_{39}
12.12. ICT usage makes imaginary concepts (e.g. magnetic field lines)real						V_{40}

SECTION E: FACTORS THAT INFLUENCE THE USE OF ICT IN TEACHING AND LEARNING OF PHYSICAL SCIENCES IN SCHOOL.

13. Please indicate your views about ICT use in teaching and learning of science, using the following indicators and placing **X** in the appropriate box.

Strongly disagree	1
Disagree	2
Uncertain	3
Agree	4
Strongly disagree	5

FACTORS INFLUENCING ICT USAGE IN SCHOOLS	1	2	3	4	5	
13.1. Government has made ICT infrastructure available to schools						V_{41}
13.2.The CAPS curriculum support ICT usage in teaching Physical Sciences						V_{42}
13.3. My school's time table allows practical work in Physical Sciences with the use of ICT.						V_{43}
13.4. The content of Physical Sciences CAPS document permits the use of ICT in teaching Physical Sciences.						V_{44}
13.5. The data-logging and the simulation software programmes available currently are compatible with the South African CAPS documents.						V_{45}
13.6. My teacher has access to software programmes which support the CAPS documents.						V_{46}
13.7. Learners have access to software programmes which are compatible to CAPS documents.						V_{47}
13.8. the use of ICT in teaching Physical Sciences is time consuming						V_{48}
13.9. Learners get too excited when ICT is used in teaching Physical Science						V_{49}
13.10. Learners can learn Physical Sciences with ICT on their own without the help from their teacher.						V_{50}
13.11. My school has enough computers for all Physical Sciences learners.						V_{51}
13.12. All schools in my district have ICT infrastructure.						V_{52}

- Thank you very much for being part and parcel of this study. May God richly bless you.