Exploring Grade 11 Physical Sciences teachers' perceptions of practical work

by

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ABSTRACT

The new curriculum introduced in the Further Education and Training phase has had a great impact on the teaching and learning of Physical Sciences in the classrooms. The policy documents for Physical Sciences emphasis that practical work to be integrated with the teaching of Science. However, much remains desired on how teachers use their Pedagogical Content Knowledge (PCK) to conduct practical work in their classrooms. This study explored teachers' perceptions of practical work in the context of the Curriculum Assessment Policy Statement. PCK was used as the theoretical frame-lens to understand teachers' perceptions of practical work.

Data in the study were collected through interviews and observations from four Grade 11 teachers. It was also collected by scrutinising teachers' portfolios. Observations were used to discover the teachers' actual classroom conduct of practical work. The sample of the study was drawn from Mankweng Circuit, in the Limpopo province. The findings of the study revealed that teachers conduct demonstrations which were structured and inquiry based practical work was not conducted. It was also found that they conduct practical work for promotional marks only. Furthermore, it was revealed that teachers appreciate the value of practical work in the teaching and learning of Physical Sciences but lack of resources and time constraints hinder them from conducting good practical work. It was also found that teachers do not have practical work lesson plans in their portfolios except those for reporting. However, apparatus in some instances were limiting teachers to conduct good practical work. Large classes, lack of time table for practical work and pressure to complete the curriculum were also mentioned by the teachers as limitations. It is recommended that subject specialists should help in developing teachers' knowledge to conduct inquiry based practical work.

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Finally, my family for the support and courage I received to make sure that I complete the study.

DECLARATION

I, MAPONYA MOKHOLWANA DAVID declare that **Exploring Grade 11 Physical Sciences teachers' perceptions of practical work** is my own work, written in my own words and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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Signature

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Date:

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LIST OF ABBREVIATIONS

CAPS	Curriculum Assessment Policy Statement
DBE	Department of Basic Education
PCK	Pedagogical Content Knowledge
PAAI	Practical Activity Analysis Inventory PAAI
(T1T1)- (T4T4)	Teacher 1 transcript 1
T 1- T4	Teacher 1-Teacher 2

CHAPTER 1

1. Background and Motivation

Practical work in Science is recognised and widely accepted as an essential component in the teaching and learning of science concepts (Toplis & Allen, 2012; Kibirige, Mavhunga & Maake, 2014). Millar (2004, p.2) refers to practical work as any teaching and learning activity, which at some point involves the students in observing or manipulating the objects and materials they are studying. Tafa (2012) refers to practical work as an active learning process with the responsibility of organising what is learned. SCORE (2008) defines practical work in science as 'a "hands-on" learning experience which prompts thinking about the world in which we live' (p. 4). That is, in Physical Sciences classrooms, practical work is as an active process where learners are engaged in the learning process. Good quality practical work promotes the engagement and interest of students as well as developing a range of skills, science knowledge and conceptual understanding (SCORE, 2008).

The purpose of practical work is to make learners aware of their environment and equip them with investigating skills relating to physical and chemical phenomena (Department of Basic Education, 2011). Furthermore, practical work should be included in the teaching of Science to provide experiences on which students can build their understanding of scientific concepts (SCORE, 2008). Practical activities in Physical Sciences refer to practical demonstrations, experiments or projects which are used to strengthen the concepts being taught (DBE, 2011). Science teaching involves the transfer of knowledge from the teacher to the learner. The direct transfer of knowledge does not work in classrooms when the teacher is teaching abstract science ideas. Therefore, learners must play an active role when taking in new knowledge (Atwater, Russell & Butler, 2014). Godwin, Adrian, and Johnbull (2015) have shown that practical work produces excellent results when used to enhance teaching and learning.

Since 1994 when South Africa became democratic, the curriculum has been changing. The curriculum changed from Curriculum 2005 (C 2005), OBE, and Revised National

Curriculum Statement (RNCS) to NCS. The New Curriculum Statement, also termed NCS and recently Curriculum Assessment Policy Statement (CAPS), brought further emphasis on practical work in Physical Sciences. Many topics from the previous curriculum are now reworked and redirected so that their value and relevance are emphasised in CAPS. Du Plessis (2013) observes that CAPS is an adjustment to what the teachers teach (the curriculum) and not how we teach (teaching methods). Physical Sciences has specific aims which relate to gathering knowledge through practical work (DBE, 2011). Learners can develop investigating skills pertaining to physical and chemical phenomena when doing practical work (DBE, 2011). One of the recommendations of CAPS is that practical work must be integrated with the theory to strengthen the concepts being taught (DBE, 2011), which is the stance of the CAPS curriculum on practical work.

The implementation of science investigations at schools presents a new challenge to teachers as it signals an opportunity to shift from a teacher-centred to a learner-centred approach in practical work (Ramnarain, 2011). Kaptan and Timurlenk (2012) further state that one-way delivery from a teacher does not work for the majority of learners when the teacher teaches abstract concepts. CAPS document guides the teachers on the content and practical work that they are supposed to teach. Kibirige and Teffo (2014) found out that there were differences between the expected according to the NCS policy documents and the educators' classroom practices. Shulman (1986) point out that teachers' Pedagogical Content Knowledge plays an integral role when interpreting and transforming subject matter knowledge to the context producing an excellent learning environment.

Ramnarain (2014) identified large classes in schools as a factor that made it difficult for teachers to interact individually with learners. As a result, learners' performance is poor in science subjects (Mji & Makgato, 2006). Lack of teaching and learning resources like libraries, laboratories, sports facilities and playgrounds are well documented across the world and teachers are still expected to do practical work in their Science classrooms (Makori & Onderi, 2014; Motlhabane, 2013).

This study explored teachers' perceptions of teaching with or without practical work in their Physical Sciences classrooms. Implementing the CAPS successfully and demanding of the curriculum requires teachers with well-built pedagogical content knowledge. Little research is conducted on teacher s' perceptions about practical work. Therefore, the purpose of this study was to explore teachers' perceptions of practical work. The study was carried out in the area of Mankweng Circuit, in Limpopo province, South Africa.

1.1 Research problem

The concept of teaching Science in schools using inquiry during practical work is a goal to be achieved (DBE, 2011). Learners ask questions to know more on the subject, look for details from the internet (Deore, 2012), books (Ward, Roden, Hewlett & Foreman, 2005) and experts (Harlen, 2006) to investigate the specific phenomenon. Currently, Science teachers attach different meanings to practical work, and these meanings seem to determine their facilitation and the quality of practical work. Teachers have naïve perceptions of practical work (Mudau & Tabane, 2014) and their actions differ with their perceptions (Mudau & Tabane, 2015). As a result, many teachers do not conduct practical work (Kibirige & Tsamago, 2013) and if they do, it is "cookbook" type (Sani, 2014), which do not improve the understanding of science. Science teaching seems to emphasize memorization which has no application to learners' day to day experiences (Onwu & Kyle, 2011). Therefore, it could be true that the concept of practical work and its meaning are poorly conceived and may hamper teachers from conducting practical work as stipulated in CAPS. Therefore, Grade 11 teachers` perceptions regarding practical work in Mankweng Circuit are poorly understood and need exploration. Therefore, the purpose of this case study was to understand Grade 11 teachers' perceptions of practical work in Mankweng Circuit.

1.2 Research questions

The main research question is: What are Grade 11 Physical Sciences teachers' perceptions regarding practical work in Mankweng Circuit?

Three sub-questions were used to drive the study and are presented below:

- What are Grade 11 Physical Sciences teachers' perceptions about practical work?
- How do Grade 11 Physical Sciences teachers conduct practical work?
- What factors motivate or demotivate Grade 11 Physical Sciences teachers to perform practical work?

1.3 Purpose of the study

The purpose of this study was to investigate Grade 11 Physical Sciences teachers' perceptions of practical work in Mankweng Circuit.

1.4 Research methodology

The study followed a qualitative approach. Qualitative research is empathetic, striving to capture phenomena as experienced by the research participants themselves (Creswell, 2013). Qualitative methodology suited the study as the researcher was investigating descriptions of practical work from the teacher' perspectives (Merriam, 1992). Furthermore, the qualitative approach is concerned with understanding social phenomena from the participants' perspectives (McMillan & Schumacher, 2014),

1.5 Research design

The study used a case study design (Yin, 2009) because the researcher needed to understand teachers' perceptions of practical work. Case study design enabled the researcher to scrutinise closely and collect large amounts of detailed data (Salkind, 2003). A multiple-case design was adopted and conducted in four different high schools with four different teachers. Multiple-case studies have discrete advantages over single case study because they produce findings that are compelling and robust. Case study design allowed the researcher to retain the holistic and meaningful characteristics of real-life events of practical work (Yin, 2009).

1.6 Significance of the study

This study was of dual significance because it will contribute to new knowledge about teachers' perceptions of practical work, how they perform practical work and factors that motivate and demotivate them to perform practical work. The findings of this research will inform practicing Physical Sciences teachers on the types of practical work used in science teaching and how to use practical work as a teaching strategy in Physical Sciences. The findings this research will assist the Department of Education in providing information about the status of practical work implementation in concerning CAPS intention in Mankweng Circuit. The results of this research will benefit specialists in planning for meetings and how practical work is perceived by teachers in the policy document.

1.7 Definition of key concepts

Definition of key terms that are consistently used in the study is listed below.

Practical work is defined as any teaching and learning activity which involves at some point the learners in observing or manipulating real objects and materials they are studying to enhance their understanding (Millar, 2004). Yet, Tsai (2003: p. 847) indicate that "practical work in school science means laboratory-based experience".

Practical activities as used in CAPS document refer to practical demonstrations, experiments or projects used to strengthen the concepts being taught (DBE, 2011)

Perceptions is defined as "an idea, a belief, or an image someone has as a result of how they see or understand something" (Oxford English Dictionary, 2000 p.80).

Scientific inquiry "centres on human kind `s probing the natural world in search of explanations, based on evidence, leading towards an understanding of reality" (Chiappetta, Koballa & Chollette, 1998, p. 36).

Scientific investigation is “defined as an activity in which learners use thinking skills and science processes skills such as formulating questions, hypotheses, predicting, interpreting data, synthesising information and making conclusion” (Chin & Kayalvizhi, 2002, p.270).

1.8 Thesis outline

Chapter one (1) provides the introduction of the study, followed by background and motivation of the study. It is in this chapter that a mini literature is reviewed together with information that the study seeks to establish. This is followed by the research problem which highlights the problem that prompted the study, research questions, and purpose of the study. Research methodology describes the design that was used to carry out the research. The significance of the study and an outline of the chapters in the thesis are described in this chapter. The outline of the current and the chapter to follow are also given in the form of a summary.

In chapter two (2), a detailed and relevant literature to the study is discussed. This begins with the introduction followed by a thorough discussion on different perspectives on the definition of practical work. In this chapter, the importance of practical work and its purpose are discussed. This is then followed by discussions of different types and forms of practical work. Studies conducted world-wide, in South Africa and Limpopo are also highlighted. The adopted theoretical framework in this study is elaborated in this chapter. The chapter also has a conclusion and summary linked to the next chapter.

Chapter three (3) discusses the methodology that was used in answering the research questions. The research design, followed by study sample, is also discussed. The research instruments that were used to collect data are discussed followed by how data was analysed. This is then followed by quality criteria, ethical considerations, followed by chapter summary respectively.

In chapter four (4) data is presented in three stages. This begins with the presentation of data that were collected from interviews with four sampled teachers. The second stage of the presentation is the data collected from the four observed teachers. This is finally followed by a tabular presentation of the data collected from teacher portfolios. The chapter also has a summary linked to the next chapter.

Chapter five (5) which is the final chapter of the study discusses the findings of the study. This is then followed by recommendations, limitations of the study, areas for future research and conclusions.

1.9 Chapter summary

This chapter presented the introduction to the background and the motivation behind conducting the study. This was followed by the research problem, purpose of the study, which also comprised of research questions that helped guide the study, the significance of the study, research design and lastly followed by the thesis outline.

The next chapter will address studies undertaken on teachers' perceptions of practical work and also highlight the theoretical framework of the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of literature related to an exploration of Grade 11 Physical Sciences teachers' perceptions of practical work in CAPS curriculum. The literature review aims to find out what is already known on the subject under study and to identify knowledge gaps. The overview of the theoretical framework Pedagogical Content Knowledge highlights the importance of teachers' PCK on practical work.

2.2 Perspectives on practical work

Different authors have defined practical work in various ways in the literature. It is important to define what practical work means in the context of this study and indicate different names that can be associated to it. According to Millar (2004), practical work refers to any teaching and learning activity which at some point involves the students in observing or manipulating the objects and materials they are studying to develop understanding. According to Millar, teachers and learners perform practical work. Thus, Millar implies that practical work engages learners in hands-on and in brains-on activities. The definition of practical work further implies that learners have to be active manipulators of objects they are studying because it helps them to understand the methods of gaining scientific knowledge. Practical work is not confined to classrooms only, but it can also be performed in an outside school setting such as student `s home or in the field.

SCORE (2008) defines practical work in science as 'a "hands-on" learning experience which prompts thinking about the world in which we live' (p. 4). This definition settles much on the hands-on learning experience. That is, in Physical Sciences practical work can then be referred to as an active process where learners are engaged in the learning process. Good quality practical work promotes the engagement and interest of students

as well as developing a range of skills, science knowledge and conceptual understanding (SCORE, 2008).

According to Woodley (2009, p. 9), practical work is a “hands-on” learning experience which prompts thinking about the world in which we live. Woodley further states that practical work can be categorised into two main categories which are core activities and directly related activities. Core activities include investigation, laboratory work procedures, techniques, and fieldwork. Core activities are the hands-on activities which support the development of learners’ practical skills.

The directly related activities include teacher demonstrations, experiencing phenomena, designing, planning, analysing and communicating results. These scientific investigation skills, provide learners with firsthand experience which is the core component of investigations. SCORE (2009) add the third category of complementary activities which are important in supporting the development of conceptual understanding in Science.

According to Tsai (2003, p. 847), practical work means an experience that is formed in the laboratory. That is, learners do practical work in the laboratory to gain experience on which they can build their knowledge of the lesson. Practical work is limited to the laboratory. However, in the modern world of technologically advanced and science micro kits, practical work cannot be limited to laboratory only.

Stoffel (2005) describes practical work as teaching and learning activities that offer learners’ opportunities to practice the process of investigation. Stoffel (2005) further suggests that investigations involve learners to practice process skills by being ‘hands-on’ and minds on, and they develop various skills such as questioning, observations hypothesizing, predicting, collecting, recording, analysing and interpreting data” (p.148). This definition suggests that practical work could be seen as a means of teaching and learning where learners develop and practice process skills.

According to Pekmenz Johnson and Gott (2005), practical work can be defined from the perspectives of the movements that influence it. Initially, they define discovery learning approach in which it is viewed as a process whereby learners find things on their own and which helps to develop their thinking capabilities. Secondly, the process approach depicts practical work as a methodology that will give learners opportunities to practice what scientists do when they act as scientists. Lastly, in the investigative approach, practical work is portrayed as a holistic approach. The main idea is that "learners should be thinking about what lies behind what they are doing rather than simply applying practiced process" (p.10). Practical work in investigative movement is the approach to teaching and learning that enables learners to develop science process skills. Investigative movement is termed procedural understanding because that is when learners develop science process skills and also develop an understanding of scientific concepts, laws and theories.

There is no clear and specific consensus on the definition of practical work. The above descriptions use various terms and explanations to define it. Millar (2004) and Stoffel (2005) in their descriptions concur that practical work develops process skills and can be performed by learners on their own or in groups. On the other hand, Woodley (2009) and Pekmenz et al. (2005) regarded it as the movements influencing the outcome. Various definitions include investigations, learners handling apparatus and laboratory procedures. Therefore, irrespective of the definition of practical work in any domain, or what could be thought to be the main activities that constitute it, it could be seen as a central part of how science should be taught in schools.

2.3 Practical work and its place within the CAPS policy guideline

In South Africa, the school calendar is nine weeks per four terms in a year. The resolute focus of the revised curriculum is that practical work must be integrated with theory (DBE, 2011). According to National Curriculum Statement Policy (CAPS), Physical Sciences as a subject focus on investigating physical and chemical phenomena (DBE, 2011). This investigation is done through scientific inquiry, application of scientific

models, theories and laws to explain and predict events in the physical environment. The purpose of Physical Sciences is to make learners aware of their environment and to equip learners with investigating skills relating to physical and chemical phenomena. Investigating skills are embedded in practical work; hence it is hands-on and brains-on.

The CAPS policy document for Physical Sciences as a subject has a list of activities which learners should engage in during practical work. The activities listed in the policy document are: collecting apparatus, classifying apparatus, using apparatus, measuring, designing an investigation, identifying and controlling variables, drawing ad evaluating conclusions, predicting skills, communicating results, interpreting results, formulating models, interpreting, predicting results, problem solving and reflective skills (DBE, 2011, p.8). The above activities can be achieved through practical work.

Physical Sciences promotes knowledge and skills in scientific inquiry and problem-solving; the construction and application of scientific and technological knowledge; an understanding of the nature of science and its relationships to technology, society and the environment. Therefore, teachers should engage learners in the scientific inquiry.

2.4 The importance of practical work in Science and within CAPS curriculum

The main aims of practical work are to actively engage learners in the activity while supporting them to develop important skills. Practical work is important because learners get familiar with practical components or apparatus (Cossa & Uamusse, 2015).

According to Millar (2004, pp, 18-19), the importance of practical work is to develop learners' process skills. Millar (2004, pp, 18-19), further state that the value of practical work is that it gives learners a 'feel' for their problematics of measurement and appreciation of the of the ever presence of uncertainty. It is also important for teaching learners experimental design. Research has suggested that learners learn better when they design and carry out investigations on their own.

Woodley (2009) suggests that practical work supports and helps learners to understand the scientific investigation processes and understanding of concepts. It also helps learners to understand the safe working conditions observed by scientists. Therefore, upon completion of learning Physical Sciences as a subject, learners should have known and applied the laboratory and other related science procedures.

Several studies over the past years have reported on teachers' understanding of the purpose of practical work (SCORE 2009, p. 5). It is reported as teachers' aims in the following statements:

- to encourage accurate observation and description;
- to make phenomena more real;
- to arouse and maintain interest; and
- to promote a logical reasoning method of thought.

The stated aims above are closed related to the learner learning scientific skills.

Practical work reinforces learning and helps learners to understand Science better (Pekmenz et al., 2005). It can further help learners to enjoy Science (Pekmenz et al., 2005). The purpose of practical work is to engage learners and thus it is important for the DOE and subject advisors and curriculum advisors to ensure that teachers conduct good practical work. Practical work brings the learners in contact with physical materials and apparatus with which they can learn to produce accurate and precise results. Without practical work, some learners may not have come in contact with some materials, equipment, and apparatus used for accurate measurement. Most of the measurement done in theory use an estimated or approximated reading, but in practice learners use instruments like Vernier Callipers to get accurate and precise reading.

2.5 Challenges of practical work in schools

Practical work aids learners to reinforce and master the subject matter taught through theory (Kola, 2013). That is, for learners to understand science better, it is done using their ability to see, hear and touch in practical. Consequently, this is better than an imaginary explanation of science theory. However, Hart, Mulhall, Berry, Loughran, &

Gunstone (2000) states that one of the reasons science fails to achieve its main laboratory instructions is that learners may not be aware of the purpose of the task they are being taught even if it is teacher demonstration. Furthermore, Crawford (2007) in his study found that some teachers were incapable or unwilling to use science inquiry in their classroom. Also, the learners' perceptions regarding scientific inquiry ~~is~~ are mostly influenced by what they are fed in the classroom. Hodson (1996) indicate that for scientific inquiry to be successful, learning environment needs to be critical and supportive for learners to enhance their learning.

Hodson (1996) indicate that the purpose of practical work need to be clear so that the demands of the curriculum can be met because by simply doing science is insufficient for promoting either conceptual understanding or an understanding of science. On the other hand, teachers need to take into account the fact that not all learners are necessarily prepared for the most open-ended laboratories. Furthermore, Hodson (1996) indicated that it has been assumed that practical work means experiments which were leading to confusions. Nevertheless, Kola (2013) states that practical work stimulates the interest of the learners to discover, and make scientific conclusion. Thus, learners become more interested in science when they make their own discoveries and scientific conclusions.

Millar and Abrahams (2009) suggest that learners occasionally learn the things that we want them to learn from practical tasks and when asked later, they tend to recall only a few of the details of the experiment. They cannot remember exactly why the experiment was undertaken. According to Hodson (1996), it is not true that practical work is the best method for delivering scientific knowledge if real evidence is taken into account. The use of practical work offers learners an opportunity to examine scientific knowledge from a different perspective, from instruction and thus it can be put to excellent use when combined with other types of instruction.

2.6 Types of practical work

Types of practical activities are the diverse practical activities performed during the teaching and learning of Science. Millar and Abrahams (2009, p. 61) classify practical activities according to their learning objectives. The practical activities are classified into three main types of their learning objectives as seen in Table 2.1 below. The classification of each type of practical activity has its own objective as outlined in the table below.

Table 2.1: Classification of practical activity and objective

	Type of practical activity	**Main objectives of the practical activity**
A	Science knowledge	To help learners develop their knowledge of the natural world and understanding of main ideas, theories and models that uses science for explanation.
B	Practical skills	To help learners learn how to use science apparatus or follow some standard science procedure.
C	Scientific Inquiry process	To develop learners' understanding of the scientific approach to enquiry (for example, learners learn how to design an investigation, assess and evaluate the data, process data to find conclusions, evaluate confidence with which these can be asserted).

According to Pekmenz et al. (2009, p.13), practical work can be classified as categories that include the following:

- Skills usage mostly important to help learners to gain skills of science like how to handle apparatus when conducting practical work;
- Demonstration by the teacher to illustrate an experiment or verify science facts to and principles;
- Illustration usage by the teacher to verify science concepts; and

- Investigation used by the teacher to provide learners with opportunities to learn and use skills to solve problems as well as develop cognitive processes.

Pekmenz et al., (2005) report that teachers in schools prefer to use demonstrations in their lessons while investigations projects are rarely executed. They further suggest that teachers do not have adequate knowledge on the types of practical work for which Millar and Abrahams (2009) suggest that if we want practical work to be effective we need to be clear and precise about its purpose.

Rogan and Grayson (2003) classify types of practical work into four levels. These levels are not in any higher order of importance. They developed a framework to study Curriculum 2005 implementation to understand the use of practical work in the real context of teaching and learning. As seen in Table 2.2 below it is the profile of implementation in which activities are classified into levels modified for teaching and learning of Physical Sciences. Level 1 and 2 are mainly teacher-centred because teachers perform the experiments. Level 3 and 4 are learner-centred and learners take lead role in executing the activities and perform the experiments. The types of practical work described in Table 2.2 were also used by Hattingh, Aldous, and Rogan (2007) in their study to define the types of practical work.

Table 2.2 Modified profile of implementation for science practical work

Level	Type of science practical work
1	• Teacher uses classroom demonstrations to help learners develop concepts. Learners remain focused in the lesson. The teacher uses variety of resources in the environment to illustrate the lesson.
2	• Teachers uses demonstration to promote a limited learner inquiry • Learners help in planning and performing the experiments. • The practical work that leaners participate in, is cook-book and closed limiting learner autonomy.

3	• Teacher designs practical work in such a way as to encourage learner discovery of information. • Learners preform guided discovery type of practical work in groups and they are hands-on. • Learners produce a report in which they can justify their conclusions.
4	• Teacher support learners to design and perform their own "open-ended" investigations and projects. • Learners make improvements by reflecting on the quality of the design and the data. • Learners can make conclusions in support of explanations or theories.

The types of practical work used by Rogan and Crayson (2003) and Hattingh et al. (2007) are relevant to this study because they have evaluated the curriculum implementation; hence in this study, the concept of practical work was explored.

2.7 Research on teachers' perspectives of practical work

Practical work in science classrooms has been examined from diverse theoretical perspectives and through some different disciplines. Presented in the literature are some of the findings found by other researchers on practical work in sciences in relevant journals.

Kim and Chin (2011) conducted a study to understand how pre-service teachers' understandings of inquiry and practical work have been shaped in educational and social contexts in Korea and later how their views and willingness could be developed through redesigning and practicing textbook activities. Mixed methods that included questionnaires and reflective discussion and writing were employed for data collection with 25 third-year students in an elementary science course in Korea. The study showed that the pre-service teachers in Korea seemed to hold narrow understandings towards inquiry and practical work. The participants regarded the inquiry process as an

open process which means students have their questions and look for answers by themselves. Their views on practical work related to the contexts where they dwelled. Although inquiry orientation was a challenging task for the students in their everyday classroom through the activities of modifying practical work they changed their ideas of failure in practical work.

Sani (2014) in Malaysia investigated teachers' purposes and practices in conducting practical work at the lower secondary school level. Six Science teachers were interviewed through in-depth, semi-structured interviews that allowed the teachers to talk about their context in their first language. The findings of the study showed that teachers considered the aim of practical work to mainly develop procedural and conceptual knowledge which can be achieved through very structured tasks. The teachers' preferred controlled exercises and structured investigations to ensure that the students did what the teachers intended them to do and learn. Controlled exercises take away all learner liberty and they may lead some learners not to engage in the practical work at all. Furthermore, Ramnarain (2011) pointed out that the investigative approach promotes greater learner autonomy.

A study by Mudau et al. (2014) investigated teachers' classroom practices by focusing on how their ideas and views shape how they conduct practical work in a Science classroom. The focus was the classroom practices from a sample of two Physical Sciences teachers in South Africa, Gauteng province. Semi-structured interviews and official documents were used to gather data for the study. The study showed that one teacher had ideas about the nature and purpose of practical work within the framework of the investigation movement. The second teacher had ideas about the nature and purpose of practical work within the process and investigation movements, respectively. Mudau et al. (2014) found out that both teachers conducted practical work tasks within the explanation model. Hence, they found that teachers' ideas of practical work do not necessarily shape how they conduct practical work. Mudau et al. (2014) suggested a need to link the understandings of practical work and of teacher practice if the inquiry approach is to be a success.

Mokiwa et al. (2014) explored teachers' instructional practices and conceptions of teaching Physical Sciences through inquiry. They collected data using qualitative research methods of individual interviews and observations with four experienced teachers who were purposively selected. Their results revealed that participants in their study used traditional classroom activities more frequently than inquiry-based activities. Furthermore, the participants who made use of inquiry followed a specific order of activities that lead to a more structured or direct type of inquiry. Few participants used a combination of both traditional classroom activities and inquiry-based activities, leading to a guided type of inquiry. However, all participants understood teaching through inquiry as a kind of pedagogy that involves experimentation. Mokiwa et al. (2014) suggest that there is a need for teachers to possess sound knowledge of inquiry and the Nature of Science (NOS); as these are pre-requisites for implementing inquiry-based instruction in the classroom.

A study by Kibirige, Osodo, and Mgiba (2014) explored Grade 7 Natural Sciences teachers' perceptions regarding the role of practical work and matched them with available evidence from teachers' portfolios. The focus was on teachers' perceptions of practical work, which they matched with the available evidence from the teachers' portfolios from a sample of 10 Grade 7 Natural Sciences teachers, randomly sampled from 27 schools in Limpopo. The researchers used questionnaires and teachers' portfolios to collect data. The study revealed that some Science teachers had misguided perceptions regarding the purpose of practical work. Furthermore, teachers were aware of the need to include practical work in their schedules but the majority of the teachers were reluctant to plan for its teaching and were not prepared to conduct as well as assess it. Kibirige et al. (2014) found that the teachers' theoretical perceptions regarding the purpose of practical work in Science were relatively adequate, while their perceptions regarding application were inappropriate.

Literature shows that some studies were conducted on educators' perceptions of practical work and inquiry. There was a paucity of knowledge on teachers' conceptions

of practical work and teachers' application of practical work in Science classrooms was inadequate. Most of the research relevant to this study was conducted on teachers' understanding of practical work and not on perceptions. In this study, three methods of data collection were used because other researchers used only two methods. Most researchers used interviews to get in-depth data and document analysis. In this study, non-participant observations were conducted so that the researcher could observe teachers actual classroom practice and most importantly relevant in the qualitative research.

2.8 Theoretical framework

The theoretical framework of this study is the Pedagogical Content Knowledge (Magnusson, Krajcik & Borko, 1999), which is an extension of Shulman `s (1986) Pedagogical Content Knowledge. Shulman originally conceptualised the construct of Pedagogical Content Knowledge (PCK) in 1986. Shulman identified the key elements in his definition as knowledge of representations of subject matter, the understanding of specific learning difficulties and student conceptions. Grossmann (1990) further identified four distinct components of PCK which are: knowledge and beliefs for teaching subject matter; knowledge of students' understanding, conceptions and misconceptions of particular topics in a discipline; knowledge of the curriculum; and knowledge of instructional strategies and representations. In elaborating on these aspects, Magnusson et al. (1999) conceptualised five criteria for PCK which include, orientations towards teaching science, knowledge and beliefs of the science curriculum, knowledge of students' understanding of science, knowledge of assessment in science and knowledge of instructional strategies. These dimensions are explained below:

2.8.1 Teachers' orientations towards science

This component of pedagogical content knowledge refers to teachers' knowledge and beliefs about the purposes and goals of teaching science at a particular grade level (Magnusson et al., 1999). Grossman (1990) labelled this component as consisting of knowledge of the purposes for teaching a subject at a particular grade level or the "all-embracing conceptions" of teaching a particular subject. The importance of this

component is that the teachers' knowledge and beliefs of science, serve as their base for selecting for selecting varied instructional decisions, learning material and aims of the lessons. Similarly, Magnusson et al. (1999) indicate that a teacher's orientation to teaching science is distinguished by his purpose for selecting the particular teaching strategy. For example, a teacher who facilitates learning for conceptual change will differ with the teacher who engages learners in discovery using practical work. Also, a teacher whose orientation is inclined to the guided inquiry will help learners' to shape their ideas using process skills than a teacher with didactic orientation. Therefore, it is important to understand teachers' perceptions of practical work before they teach learners.

2.8.2 Knowledge of curriculum

In this dimension, teachers should possess the knowledge about content areas and specific aims for Physical Sciences that are highlighted and discussed in the CAPS curriculum. In this way, teachers will know the content they are supposed to teach, and how to teach it. Botha & Reddy (2011) found that the pre-service teachers do have a sound understanding of curriculum ideas as presented in the DoE policy documents and but they lacked the confidence to teach or do practical work. Hodson (1998) states that judgment of the activities given to learners is relates to the teachers' knowledge of learners, and the content in the curriculum. Therefore, it is necessary for teachers to know the requirements of the science curriculum and content they teach.

2.8.3 Knowledge of students learning

PCK is not a simply procedure, but it is combination of rick knowledge of pedagogy and content together shaping and interacting with each other so that what is taught and how it is constructed is purposefully created to ensure that that is learned is better understood by learners in the given context (Loughran, Berry & Mulhall, 2012). So, science teachers must have a better judgment of selecting more than just the content and basic facts to be learned. They must know science concepts which learners find

difficult to learn so that they can help them to develop science understanding. Furthermore, they must know misconceptions which learners have in a specific topic so that they can plan lessons that promote conceptual change (Halim, & Meerah, 2002; Magnusson et al., 1999). Also, when teachers have insufficient content knowledge, they will not be aware of students' misconceptions (Bektaş, 2015) and as a result learners' knowledge of science will be minimal, fragment and at best guided by misconceptions.

2.8.4 Knowledge of instructional strategies

For the instructional dimension, teachers are the knowledge custodians of teaching strategies they can use to teach a certain subject and also the strategies they can use to teach specific topic (Magnusson et al., 1999) and this is what is expected of every teacher. This is because an effective teacher will select best methods to present specific concepts to learners to facilitate learning. Likewise, Halim & Meerah (2002) states that teachers should use pictures, drawings, examples, models, videos as their teaching strategies to help learners to understand specific science concepts. Furthermore, teachers have to know the positive and negative effects of using demonstrations or experiments to explain certain science topics. Abrahmas & Reiss (2012) found that practical work is effective in developing learners conceptual understanding if they are to be engaged in a "hands-on" and "minds-on" approaches.

2.8.5 Knowledge of assessment

For the knowledge of science assessment dimensions, teachers' have knowledge to assess the specific aspects of student learning that are important to a particular unit of study (Magnusson, et al., 1999). That is, teachers need to know what, how and why the skills to be assessed. Teachers' knowledge of methods of assessment include knowledge of specific instruments or approaches or activities that can be used during a particular unit of study to assess important dimensions of science learning, as well as the advantages and disadvantages associated with employing a particular assessment device or technique.

This framework fit in this study in that teachers' performance, planning, presentation, and assessment of learners' practical work in class depending on the perceptions they have towards practical work. Also Kind (2009) indicates that PCK is more complex and develops overtime. Furthermore, PCK arises from intensely varied human interactions in a variety of situations. Magnusson et al. (1999) conceptualised five criteria for PCK used as the theoretical lens in this study.

The teacher is central to the implementation of the curriculum. The concept of PCK in this study was used to understand the Grade 11 teachers' perceptions regarding the use of practical work in teaching Physical Sciences. The CAPS curriculum requires that teachers recognise and address barriers to learning, and plan for diversity in their classrooms. Teachers should use various curriculum differentiation strategies in their classrooms to cater for diversity. Shulman (1986, 1987) suggests that teachers need strong PCK to be the best possible teachers.

2.9 Chapter summary

This chapter addressed literature undertaken on practical work. The chapter began with an introduction followed by a thorough discussion on the definitions of practical work. The types and purposes of practical work were also discussed. Studies conducted world-wide, in South Africa and Limpopo on teachers' perceptions of practical work was also highlighted. The theoretical framework tenets with the pertinent issues are highlighted in this chapter.

The next chapter discusses the research methodology employed in this research.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a complete description of the research design and methods that were used in this study. The research design is described and justified. The chapter further describes the sample, data collection methods and data analysis techniques used in the study. The chapter further describes and justifies quality criteria and delimitation of the study.

This study was intended to investigate teachers' perceptions of practical work. For the realisation of these intentions, a qualitative approach was used. According to Creswell (2013), qualitative research is defined as an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The researcher builds a complex, holistic picture, analyses words, report detailed views of informants and conducts the study in a natural setting. The aim was not to change the situation, but to investigate how teachers conduct practical work in their lessons.

Qualitative research is empathetic, striving to capture phenomena as experienced by the research participants themselves (Creswell, 2013). Qualitative methodology suited the study because the researcher intended to widely capture the descriptions of practical work (Merriam, 1992) from the teachers' perspectives. It also suited the study because the researcher intended to investigate teachers' perceptions of practical work which was given as narratives not as numbers.

Qualitative research was also chosen because belief and practices can easily be identified. According to de Vos (2001: 243), qualitative research involves identifying the participants' beliefs and values that underlie the phenomena. Furthermore, in qualitative research there is no fixed recipe to follow (de Vos, 2001) which means there is flexibility in this type of research.

3.2 Research design

A case study design (Yin, 2014) was used in the study and is defined as an empirical inquiry that investigates a contemporary phenomenon in depth and within its real life context (p.18). Case study inquiry relies on multiple sources of evidence. The data converge in a triangulation approach. This was the researcher `s intention, to collect data from different sources to investigate teachers' conceptions of practical work. May (2011) holds the same view on multiple sources of data. Case study design allowed the researcher to retain the holistic and meaningful characteristics of real-life events of practical work (Yin, 2009).

Case study is a method used to study an individual or institution in a unique setting in an intense detailed manner (Salkind, 2003). Stake (1995) states that a case study is an exploration of a system, multiple cases describing time and place. Multiple sources of information include observations, interviews, audio materials and documents and reports. In order to explore Grade 11 Physical Sciences teachers' understanding of practical work, a case study method seemed appropriate. The researcher was interested in the existing conditions surrounding the person as much as the person himself. That is, the interest was in the teacher and his/her methods of teaching using practical work. Salkind (2003) further states that the quality of the uniqueness of the case sets the person from others. Hence, the Grade 11 teachers in the study are unique from grade 10 and 12 teachers. Salkind (2003) further state that, there is simply no way to gather a richer account of what is occurring than through a case study.

The aim of the research was to grasp what is happening in the classrooms in relation to practical work and make recommendations thereof. Salkind (2003) indicates that case studies are not generalizable and they provide directions for further study. Nevertheless, case study design was chosen since generalisation was not the key focus.
A multiple case design was adopted as the study was conducted in four different high schools with four different teachers. Multiple case studies have discrete advantages over single case studies because they take into consideration the diversity of cases.

According to Sarantakos (2005), case studies investigate social life phenomena within parameters of openness, communicative and naturalism and interpretative as informed by interpretative paradigm. Hence, the researcher wanted to investigate teachers' understanding and how they conduct practical work. Sarantakos (2005) further states that case studies focus on direct and verifiable life experiences. Hence, in the study observations were conducted to verify teachers' real practices of practical work.

3.3 Study sample

Walliman (2001) define a population as a collective term used to describe the total quantity of cases of the same type which are subject of a study. A sample is therefore described as a number of cases in a population. According to Cohen et al. (2007) sampling is important in the research because sometimes it is difficult to study the whole population; therefore a small sample is used. Walliman (2001) goes further to say for a qualitative study to be detailed; the researcher uses a small number. Hence, the researcher investigated teachers' perceptions of practical work and a small number of participants was used for this qualitative study.

A purposive sampling (Cohen et al., 2007) of four Grade 11 Physical sciences teachers from different schools participated in the study because the researcher wanted to identify their experiences (Given, 2008) of teaching Physical Sciences using practical work. Furthermore, Leedy and Ormrod (2005) indicate that in purposive sampling people or units are selected for a particular purpose. Most qualitative studies (Mudau & Tabane, 2015) used a smaller sample rather than large random samples to investigate teachers' perceptions of practical work. Small samples are cheaper and they are not time consuming. Schools were selected on the basis that they had adequate resources to conduct practical work.

Qualified teachers were selected with at least a teaching diploma and a minimum of two years teaching experience in the current school at the time of data collection. Experienced teachers were selected because they are potentially relevant sources of

information. Teachers in schools with adequate resources to facilitate practical work were purposively selected. This eliminated lack of apparatus and other relevant resources as the main reason for teachers to conduct practical work in a particular way.

3.4 Data collection

Three methods of collecting data were used, namely, individual interviews, classroom observations and official document analysis.

3.4.1 Individual interviews

According to (Waller, Faruharson, & Dempsey, 2016), there are three main interviews. These include group interviews, unstructured interviews and semi structured interviews. In group interviews, or focus groups, the researcher works with group of people (5-8) simultaneously (Punch, 2005). The role of the researcher in focus groups changes from researcher to facilitator or moderator. The facilitator direct questions to the group and records their interaction. However, this was not the researcher`s intention.

Unstructured interviews are not uniform, rather open-ended and prolonged conversation (Punch, 2005). Waller et al. (2016) further states that in unstructured conversation, the researchers focus on the main concepts that they are researching. These interviews did not suit the study because the interviews were semi structured.

Semi structured interviews is when the questions are set beforehand (Waller et al., 2016). Questions are read out in the order or in written form with empty spaces provided for the participants to fill in the spaces. Semi structured interviews were used to collect data because questions were set beforehand. Wallikind (2001) indicates that interviews are useful if the researcher wants qualitative data and descriptive data (Bertram & Christiansen, 2015). This was what the researcher intended to get, qualitative and descriptive data from the participants. Walliman (2001) indicates that an advantage of interviews is that the researcher is in a good position to get raw opinions and judge the quality of the responses of the subject. Interview place the researcher in a good position

to notice if a question has been properly understood and to reassure the respondents to be full participants and also to be full in their answers. This is what the researcher intended, to get more in-depth data from the participants. Interviews are easy because they are easier for the respondents to talk to an interviewee than to write long essay responses. Semi-structured interviews were used because they leave time for further probe into the answers. Bertram and Christiansen (2015) hold the same view that interviews allow the researcher to ask more questions to obtain more detailed information.

An interview schedule was prepared in advance because according to McMillan and Schumacher (2014), topics and questions are structured by the interviewer in advance. The questions were based on the research questions. However, because it is a semi-structured interview, the researcher deviated where necessary to get detailed data. Face-to-face interviews were conducted and they were 30-45 minutes each. Questions from the interview schedule were asked to each participant in the same order. Data was audio taped after consent was granted by the participants. Research ethics require the interviewee to have consent if their utterances are to be recorded.

3.4.2 Classroom observation

Observations are key in qualitative research in that they refer to looking at and analysing things (Waller et al., 2016). An observation is an independent way of looking into a situation and by observing we can actually see what people do. Walliman (2003) provides two types of observations, being participant and non-participant observation. The participant observer is seen as involved in the process or activity to be observed (Punch, 2005). The observer takes part in the activities in order to gain a better perspective of the participants' views. However, this is not what the researcher intended to do, to take part in the lesson when the teacher is teaching using practical work.

Non-participant researcher takes a detached stance to the phenomena with the aim to be invisible either in fact or in effect (Walliman, 2003), and thus act as complete observer (McMillan & Schumacher, 2014). This is what the researcher intended, not to

be part of the phenomena being observed. Non-participant classroom observations were conducted because they enabled the researcher to collect information on the physical setting, human setting, and interactional setting (Cohen, et al., 2007). This further gave the researcher the opportunity to gain a deeper insight and understanding of the problem in my study.

Salkind (2003) states that direct observation is not obstructive, which means the researcher allow the normal activity of the environment to proceed without interruptions. Teachers' normal day-to-day practices of practical work were not interrupted. Classroom observations were prior arranged for observation and the position of the researcher was at the corner of the classroom not obstructive to the lesson but yet able to observe the whole lesson.

Observations record whether people act differently to what they say or intend (Walliman, 2003). Therefore, the researcher selected to observe passively so that classroom instructional practice could be captured in corroboration to what was described as practical work. Contrary, other people demonstrate their understanding of a process better by their actions than verbally explaining the knowledge. That is, a teacher can demonstrate a highly organised practical work in practice rather than explaining what practical work really means. However, a teacher with good PCK can explain and demonstrate a productive practical work.

Non-participant observations were used to collect data on teachers' use of practical work and their instructional practice. Initially, the researcher planned to observe three lessons per teacher, but ended up observing one lesson because the participants did not agree to be observed three times. Teachers raised a challenge of resources and time to be observed three times. Assumingly, this might have been the case because they felt uncomfortable with being recorded while teaching. During the observations, the researcher sat at the back of the laboratory so that the events could not be disturbed, rather be observed. A modified framework of the Practical Activity Analysis Inventory (PAAI) of Millar (2009) was used as a checklist to eliminate bias. Activities

that took place in the classroom during the day of observations were noted using analysis checklist.

3.4.3 Official documents

Documentary data offers the researcher information about the organisation and this data is collected in conjunction with other interviews and observations (Punch, 2005). Yin (2014) indicates that the main use of documents is to corroborate the evidence from other sources. Data from interviews and observations were triangulated with data from the documents. The participants' portfolios were scrutinised. They were scrutinised because they offer a different perspective and information is obtained with little or no contact between the researcher and the participants (McMillan & Schumacher, 2014). Documents serve to confirm or contradict information gathered through other means. The documents that were scrutinized included: teaching plans, lesson plan designs of practical activities, worksheets for practical work, and assessment tasks for practical activities. Search for documents was conducted at the participant `s convenience. Consent was given by the respective teachers to scrutinise their portfolios in their presence.

3.5 Pilot study

A pilot study is a trial route that the researcher takes in preparation of undertaking the study. The researcher validates the methods and tools of the study. According to McMillan and Schumacher (2014), it is helpful to pilot newly developed research tools so that they can be valid. McMillan and Schumacher (2014) further state that it is necessary to pilot a newly developed interview schedule so that bias and procedures can be confirmed. The researcher used one (1) teacher from one of the neighbouring schools who was not forming part of the main sample for piloting instruments. Based on the recommendations some questions were adjusted (McMillan and Schumacher (2014). It was learned during the pilot that questions from the interview schedule were too long and need to be redefined and shortened so that they are understandable to the interviewee. The length of the interview was too long and it was re-assessed and made

shorter so that the respondents did not get tired and bored. Before the interview, the researcher broke ice by having a conversation with the respondent about the general Grade 12 learner's performance of Physical Sciences. This enabled the participant to be more open and create a friendly feeling so that he can open up. Body language and posture were learned how to be maintained during the interview to eliminate bias.

Documents analysis checklist was also piloted using the same teacher. It was learned that some descriptions form the checklist were inappropriate and they were corrected during pilot. The supervisor helped to correct the descriptions. Wording on the checklist was changed because they were vague.

Observational schedule was piloted with the teacher teaching a class of 30 learners in groups six learners, thus five learners per group. The description codes were corrected by the supervisor. This helped to record exactly what transpired in the classroom.

3.6 Data analysis

Data for each teacher was analysed separately and then combined to form themes. Data were analysed according to the following sub headings:

3.6.1 Interviews

The audio data from the interviews was transcribed into text. The data from interviews was analysed using open, axial, and selective coding (Strauss & Corbin, 1998; Grbich, 2007). In open coding, data were read sentence by sentence to get main ideas. Main ideas were grouped to make sub categories in axial coding. Emerging sub categories formed patterns and finally were grouped into themes.

3.6.2 Observations

The data collected from classroom observations were examined, labelled and coded. Data were presented in a tabular format so that key features could be identified. Patterns formed were categorised and formed themes.

3.6.3 Documents

The data from the documents were described in a tabular format. In dealing with descriptive validity (Maxwell, 1992), the researcher described what he saw from the official documents.

3.7 Quality Criteria

Describing, classifying and interpreting are at the centre of qualitative data analysis and they involve identifying relevant themes, recurring language or ideas and patterns of belief. The themes of meaning emerged from this phase where there were categories identified. These categories were internally consistent yet distinct from one another (De Vos et al., 2005:348).

To follow is a detailed look at the trustworthiness in this study. Lincoln and Guba (in de Vos et al, 2011:419-421) proposed four constructs that accurately reflect the assumptions of the qualitative research and they are described and made applicable in this study.

3.7.1 Credibility

Credibility in a qualitative research refers to the degree to which a study's findings represent the meanings of the research participants (Lincoln & Guba, 1985). To achieve credibility, a qualitative research must manage the risk of research reactivity and bias (Padgett, 2008). Rapport was established with the participants so that they were free to participate. Gestures and facial expressions were taken into consideration during the interview so that the participants' responses were not biased and this was learned when the methods were piloted. After the data was transcribed, the researcher took the

transcripts to the participants so that they can verify them as their actual responses. This was conducted so that the transcripts reflect teachers' actual responses.

3.7.2 Transferability

Transferability is the degree to which findings are applicable or useful to theory, practice and future research according to (Lincoln & Guba, 1985). The findings of this study were specific to four Physical Sciences teachers in Mankweng Circuit, and it was a challenge to generalise the findings to other populations. However, to overcome that, a description of the schools and participants is provided so that comparison can be made. In addition, the researcher described the research design and methodology to allow the study to be repeated.

3.7.3 Dependability

Dependability is about how the findings are consistent and could be repeated (Lincoln & Guba, 1985). The research process and findings were subjected to external audit by the supervisor to foster accuracy of the research and to assess the adequacy of the data.

3.7.4 Confirmability

Confirmability as defined by Lincoln and Guba (1985) refers to the ability of others to confirm or corroborate the findings. This was addressed in this study by an audit of the research process by the supervisor. The findings of this study were checked by peers who are knowledgeable in qualitative research.

3.8 Ethical considerations

Ethical considerations are particularly complex when you are using human subjects. McMillan and Schumacher (2014) maintain that ethics are concerned with beliefs about what is right or wrong from a moral perspective. The researcher adhered to the ethical issues as the study involved teachers. The researcher adhered to the ethics guidelines as set and described by the University of Limpopo ethics committee. The researcher obtained ethical clearance from the ethics committee of the University of Limpopo (Appendix E). The researcher then obtained a letter of approval from the Limpopo Department of Education before visiting the schools (Appendix F). An application letter was sent to Mankweng Circuit and permission was granted to visit schools (Appendix G). School principals were visited and the researcher sought permission to conduct research in the schools and the researcher presented a letter (Appendix D)

Permission was granted by the schools Head of Department of Physical Sciences to conduct research. Teachers were given letters outlining the intentions of the research (Appendix E). Teachers signed consent forms to be part of the research. The researcher was open and honest with the participants about the purpose of the research. The participation in the study was voluntary and the participants were not compelled to participate. Participation was voluntary and participants signed a consent form detailing information of the study. Participants were assured that the information that they shared was to be kept confidential. Participants were assured that their names and that of the school were not to be mentioned anywhere in the analysis.

3.9 Chapter summary

This chapter focused on the research methodology employed in the research. The research design was described and justified. The sample, data collection instruments and data analysis were also described and justified. In this chapter, the quality criteria of the study and ethical considerations were deliberated. The next chapter will present the results and the interpretations of the data collected in this study.

CHAPTER 4

RESULTS

4.1 INTRODUCTION

In this chapter results from the interviews, observations and document analysis are presented. Data were analysed qualitatively so that the researcher can get teachers in-depth conceptions regarding practical work. Data form the interviews were manually analysed. Firstly, data from the interviews were recorded. Secondly, it was transcribed from the tape recorder onto paper. The data was read over and over again so that the researcher could familiarise himself with it and also get main ideas. This was done in order to get emerging themes in the interviews. Teachers' responses from the interviews were interpreted in such a way that they did not lose meaning from the teachers' actual descriptions. Data from the observations and teacher portfolios were analysed to support data from the interviews.

The results from the interviews are presented below in themes and subthemes. Firstly, teachers' perceptions are presented as a theme of mixed perceptions of practical work. Secondly, the perceptions are presented as subthemes of teacher demonstration. Lastly, they are presented as subthemes of teachers performing experiments for reporting purposes. Themes and sub-themes are discussed below together with supporting comments. Results from the observations are described and presented with supporting vignettes. Results from the teacher portfolios are presented in tabular format.

4.2 RESULTS FROM INTERVIEWS

4.2.1 Theme 1: Mixed perceptions of practical work

First and foremost, all four teachers had an abstract understanding of practical work. Their perceptions of practical work were hazy and not clear. Their definitions of practical work varied with what could be defined as practical work in the CAPS policy document

for Physical Sciences. In Table 4.1 below, themes and sub-themes of the results are presented.

Table 4.1: Results from interviews

Theme	Sub-themes	Teacher no:
Mixed perceptions of practical work	Observe	1
	See things	
	Hold materials	
	Investigate	
	Investigation	2
	Engaged	
	Holding apparatus	
	Manipulating	
	Develop understanding	3
	Scientific knowledge	
	Motivation	
	Engage	4
	Investigation	
	Collect results	
	Produce report	

Teachers perceived practical work as an activity where learners hold materials. Presented below are some of the illustrative extracts from the interviews:

Teacher 1 (T1T1) stated:

> *"Ok practical work is when learners observe and see things. Learners hold material and they observe anything that we are doing in the laboratory. They observe while they are investigating laws. It is like they investigate things in science as you know scientists are always investigating."*

Teacher 2 (T2T2) mentioned that:

> *"According to my understanding, practical work is an investigation where learners are engaged.*" Probing further on what is meant by engaging learners, Teacher 2 (T2T2) further added that: "*learners are in the laboratory holding apparatus and manipulating them to get answers to their learning activity. You know, they are working in the laboratory doing experiments with me."*

Teacher 3 (T3T3) mentioned that:

> *"Practical work is a task that develops learners understanding of science. It enhances learners' scientific knowledge and motivates pupils by stimulating their interest.* The teacher further mentioned that: "*For example, in my case we have many learners doing science because of this these practical tasks."*

Similarly, Teacher 4 (T4T4) added that:

> *Practical work is an investigation that engages learners. Learners are engaged into the practical activity and they do it by themselves or maybe with supervision. Learners investigate and collect results of what is happening, maybe during the observation.*

4.2.1.1 Sub-theme 1: Demonstration

Table 4.2 below shows themes and the sub-themes that were used to categorise teachers' perceptions of practical work.

Table 4.2: Themes and sub-themes of teachers' perceptions of practical work

Theme	Sub-themes	Teacher no:1
	Investigation	
	Learners observe	
	Demonstration	
	Experiment	

Demonstration	Differentiate concepts	
	Writing a report	
	Investigation	**Teacher no:2**
	Explorative task	
	Demonstration	
	Observation	
	report writing	
	Follow procedure	
	Group learners	
	Submit a report	
		Teacher no:3
	Investigation	
	Experiment	
	Handouts	
	Report	
		Teacher no:4
	Investigation	
	Demonstration	
	Work as a group	
	Procedure to follow	

All four sampled teachers' understanding of practical work was demonstration. Teachers preferred to conduct practical demonstration. They also preferred to group learners when they perform practical work. They further gave various reasons why they performed practical work in the manner they conducted it. They defined the types of practical work as an activity that enabled learners to use skills and to manipulate apparatus.

For example, Teacher 1 (T1T1) mentioned that: *"I know to experiment and to do demonstration. Mmm… yah that's all"*. The teacher was asked how practical work was conducted and she said that: *"we have conducted demonstration, investigation, and*

experiment". Teacher 1 (T1T1) had her reasons for conducting practical work in the particular way she had conducted it. In support of why she conducted practical work in the way she conducted it, teacher 1 mentioned that (T1T1) "*Now this is because as you can see we have laboratory but the apparatus are not enough. I demonstrate on that table and then my learners follow from the demonstration. I do this as a precaution because my learners can hurt themselves".*

It is clear that Teacher 2`s understanding of practical work was demonstration. This is evident from his statement:

"*eish, you see if I want my learners to investigate, I will lead them to a task that enables them to investigate very well and if they do it, it will be after I have demonstrated. Because you know we work on a very limited time, I sometimes book them a laboratory in the University of Limpopo and they help us there. I do this if I have a challenge with the task".* The interview with Teacher 1 indicated that the teacher conducted demonstration because of lack of time.

When asked about the types of practical work he conducted Teacher (T2T2) stated that: *"errr I know problem-solving, practical tasks, skills practical, observational, investigation and explorative tasks".* The teacher took a long pause to respond. Teacher 2 had knowledge about different types of practical work.

Teacher 2 (T2T2) further stated that: "*err we did investigations and explorative tasks where learners observe".* The teacher further said that "*mmm you see when learners investigate, it helps learners to understand scientific concepts or principles better".* Apart from different types of practical work that the teacher gave, demonstrations still cropped up more often during the interviews.

When asked about how practical work was conducted: Teacher 2 (T2T2) said that *"we did investigations and experiments".* To support why the types were conducted, he mentioned that: "*they help learners to understand science better. So I may also say it also engage learners in the task. I mean you will see that learners are engaged in the*

task. Experiments mmm I can say they offer learners a chance to experiment the real process of science. We have Saturdays when we come to do experiments".

Teacher 4 (T4T4) added stating that: "*we did investigations and demonstration".* This was evident that teachers preferred to conduct practical demonstrations. Teacher 4 also added that lack of time hindered most teachers to conduct good practical work. This was also evident from the Teacher 4's statement:
"I do, I always push my learners to achieve the aims of the lesson, but in some cases, due to time we do not do all the activities".

4.2.2.2 Sub-theme 2: Teachers performing practical work for reporting purposes.

Below Table 4.3 shows the themes and sub-themes of teachers' conceptions of practical work.

Table 4.3: Teachers' perceptions of how they conduct practical work

Theme	Sub-themes	Teacher No:
Teachers conducting practical work for reporting purposes	Report for CASS	Teacher1
	Enjoy science	
	Curriculum requirements	
	To write a report	
	Learners learn best	
	To expose learners	Teacher 2
	To develop practical skills	
	To write report	
	Learners acquire skills	
	Solve problems	
	Engage learners	
	Develop skills	

	For learners to concentrate	
	Engage learners	Teacher 3
	Understand better	
	Develop skills	
	Acquire process skills	
	Learners enjoy science	Teacher 4
	Assessment plan	
	For CASS purposes	

All teachers' four sampled teachers conducted practical work for reporting purposes only. They conducted practical work to satisfy the requirements of the curriculum and for learners' progression. The Physical Sciences programme of assessment requires that teachers must conduct one formal practical task per term. Practical work was conducted mainly to grade learners as per the curriculum requirements.

For example, Teacher (T1T1) stated that: "*To be honest with you Mnr, I only do the practical work when we report per assessment guideline."* Teacher (T1T1) further mentioned that: "*I always want my learners to be best performers, so that is why I conduct practical work. I also do it mainly for marks*."

Also, Teacher 4 (T4T4) added that: "*we conduct practical work once or twice in a term. But the minimum is one per term. If we conduct one task it will be for CASS. Apart from that, we have few apparatus so to conduct it we need apparatus which we don't have. The department does not offer us apparatus it is only a mini-lab with few apparatus."* Teacher 4 (T4T4) further mentioned that*: "Firstly I am pushed to do practical work in that it is recommended in the assessment plan. Secondly, I conduct practical work because learners enjoy it."*

On the other hand, Teacher 3 had a similar sentiment with the other two teachers that practical work was conducted for assessment purposes only but she also offered

another perspective of their institution on the number of practical tasks. For example, Teacher 3 (T3T3) said:

"*If we are lucky we perform two practical tasks per month. I demonstrate those tasks because of time. And I also use this just to help learners understand. We also performed three main practical tasks in the laboratory. When I say three main is because we are required to report with one main practical work per term. We have 1 formal task per term and other informal practical tasks".* The following sentiments confirmed that teachers in schools conduct practical work for reporting only.

However, during the interviews Teacher 2 mentioned a different perspective on how practical work was conducted. Teacher 2 (T2T2) stated: "*Err I may say when I conduct practical work I want my learners to be engaged. I want my learners to be hands on. I want my learners to develop investigating skills, I want my learners to be able to concentrate on what I am teaching about and they will also be focusing".* The teacher mentioned the investigating skills; however, he did not go further into identifying those types of skills he would want learners to develop. He also mentioned that motivation keeps learners focused on the task.

During interviews it was found that teachers conducted practical work for assessment purposes only. However, they also acknowledged the value of practical work in a lesson. The most common issue that was found from the teacher interviews is that they do not plan for practical work. Instead, they conducted structured practical work once in each term.

4.3 RESULTS FROM OBSERVATIONS

Results from observations were analysed so that they could supplement the results from interviews and teachers' portfolios. The results from the observations are presented as Lessons 1 to 4 from the four sampled teachers. Findings of the lessons are presented followed by the vignette from the observed lesson.

The aims and design of the learning activities were stated in all the observed lessons. Learners were issued with hand-outs with stated procedures on how to carry out the activities. Teachers preferred to demonstrate to learners. Each practical task was communicated to learners before carrying out the activity.

Lesson 1, Teacher 1

The lesson started with the revision of concepts of forces. The teacher further introduced Newton`s laws of motion. The teacher explained the concepts of mass, acceleration and velocity to learners. Hand-outs of the practical task that was to be conducted were distributed to learners.

Teacher 1 discussed the aim of the activity with the learners. The aim of the activity was to allow learners to use ticker timer to investigate the relationship between force and acceleration. The teacher explained the aims of the activity to the learners. Learners were to investigate the effect of acceleration when mass is increased.

The activity was designed with a set of stated procedure and questions which were given to the learners together with the procedure. The activity was designed with steps that the learners were to undertake to complete the activity. The teacher pressed the ticker timer to illustrate to learners how it works.

The teacher did not allow learners to hold most of the apparatus of the lesson, learners only held the tapes. Learners observed the ticker tape being put on the ticker timer. The teacher assembled the rail for the masses. Each group representative was sent to the teacher with the tape to have dots marked on the tape by the timer. Learners used the dots on the table to calculate the time and acceleration of different masses when put on the rail. Each group completed the given tables and a whole class discussion followed. The teacher terminated the discussions by saying that when learners increase masses of objects, the force will increase and acceleration will decrease. She did not take any other contributions from the learners. Learners used the dots to complete the whole of

the given worksheet. The teacher emphasised that learners should make sure that they complete the worksheets as a purpose of the task is for assessment. Below in Table 4 Vignette 1 shows Teacher 1`s classroom actions. The vignette presents the duration of the lesson, speaker, classroom actions and the observed teacher and learner interaction.

Table 4.4: Vignette 1, observations from teacher 1 classroom practice

Time	**Speaker**	**Text/ teachers classroom actions**	**Observation**
10h00 - 10h06	T 1	*Teacher 1: "eh, good morning class, today we are going to learn or explore the concept of acceleration, mass, gravitational force and the relationship between forces. Firstly am I sure we all know what a force is".*	The teacher describe the aim
10h10 - 10h15	T1	*"Guys can you see the design of the activity. Read thought the task and ask questions"*	The teacher read the design with the learners.
10h18 - 10h20	T1	*"So, now we are going to do our practical task. I am going to give you the tapes. With those tapes you are going to bring them here and I put them under this ticker timer"*	The teacher demonstrate how the ticker timer works by press it and releasing the objects
10h22 - 10h23	Learner	*Learner: "so we are not going to press the tape for ourselves?*	The learner was disappointed in that he is not going to handle the apparatus
10h30 -	T1	*Teacher: "yes, because we only have one and it is borrowed we don't have to break it"*	

10h32			
10h35 - 10h45	T1	*Please each one of you should come now and we put each group's tape on the machine here and collect their tape*	Each learner from the group went to the table to get the tape
10H4-10H50	T1	*"Wait class……. (Said loudly). We have to fill in the tables below. The tape has the space for time and the space for acceleration. Then we draw the graphs for different tapes".*	Instructions on how to fill in the tables are given by the teacher.
10h52 -10-56	Learners	*"So, mem we are going to submit this hand-out after we have calculated different times here".*	The learners responded together
10h57 - 11h00	T1	*"Let me remind you, (said softly), those of you who do not submit the hand-out will not have the marks for the practical"*	All learners nodded

Lesson 2: Teacher 2

Lesson 2 was about determining which objects obey Ohm `s law. Questions were given out to learners with the stated procedure on the worksheet. Learners collected data and recorded it per table. They were seated in groups of five to eight per table. They collected data to calculate voltage/current. The teacher explained to the learners how each of the wire, voltmeter, and ammeter will be connected.

The teacher used the demonstration to enhance learners' understanding of Ohm `s law. He used one level of thought to help learners visualise the experiment. When he used the demonstration, he forever indicated lack of resources. Learners collect data and record it on the table. They collected data and used Ohm`s law to calculate the potential differences. In some cases, the whole class discussed the demonstration in which the

teacher often reminded learners of the importance of finishing the task on time. Worksheets were given to the learners and they completed the tables on the worksheets. The formula was not derived; instead, it was used to calculate the differences.

Vignette below in Table 2 present the summary of the observations from the teacher`s lesson.

Table 4.5: Vignette 2 observations from Teacher 2 classroom practice

Time	**Speaker**	**Teacher`s actions in the classroom**	**Observation**
09h0-09h10	T2	*"By doing this activity you are will be determining which objects obey Ohm`s law"*	The teacher used English, the teacher explained the aim to the learners
09h12-9h20	T2	*"There goes the light when we connect it with the wires and the battery. Now I have two connections that I want to show you. The first one we will connect cells in parallel, the other one we will connect it in series. You will have to observe the brightness in different connections. Now remember once we connect we will have our experiment. Now let's have a look how that happens"*	Design of the learning activity

09h23-09h35	T2	*"I am going to demonstrate one, and in groups your connect like I have connected and record the readings"*	Learners were observing the connections form the demonstration.
09h37-09h38	Learners	*"Sir, we are now we are going to connect and take recordings"*	The teacher replied yes.
09h39-09h41	T1	*"learners follow stated procedure when you connect the ammeter"*	Learners connected according to the illustrated picture of the procedure.
09h50-10h00	T2	*"Observe the ammeter and the voltmeter when you add cells and take readings"*	Learners observed form one connection and made results.
10h05-10h10	T2	*They use the graph paper to plot the results. Calculate the resistance using the given formula. draw a graph of V against I.*	

Lesson 3: Teacher 3

The lesson started with the teacher recapping the demonstration of the previous lesson. Answers were written on the board and learners marked the task. The teacher went on to introduce Chemical and Energy change as the topic for the day. She also introduced different types of reactions as the activity for the day. The teacher explained the aims of the activity to the learners. See vignette 3 below:

Table 4.6: Vignette 3 observations from Teacher 3 classroom practice

Time	Speaker	Text	Observation
12h03-12h09	T3	*"When doing this activity you are going to investigate exothermic and endothermic reactions. You are going to follow the following procedure."*	The teacher explain the aim of the activity to the learners
12h10-12h13	T3	*"If your lid does not have a hole for a straw, then cut a small hole into the lid."*	The teacher demonstrated how to cut the lid
12h16-12h20	T3	*"Pour some citric acid into the polystyrene cup, cover the cup with its lid and record the temperature of the solution"*	The teacher further demonstrated the experiment by pouring the acid
12h23-12h29	T3	*"Now, stir in the sodium bicarbonate, then cover the cup again".*	Learners from different groups covered the experiment
12h37-13h00	T3	*"Immediately record the temperature, and then take a temperature reading every two minutes after that"*	Learners completed the activity
13h00-13h35	T3	*"Record your results, and calculate. I want to find the readings on the hand-outs that I gave you".*	The teacher concluded that the learners submit reports.

Learners did not carry out an experiment; instead, they were given thermometers with readings to record them on the hand-outs. The teacher focused on the tables to be completed correctly, rather than learners carrying out the experiments.

The second part of the experiment used apparatus like Vinegar, steel wool, Thermometer, polystyrene cup and plastic lid. The teacher indicated that the lesson would not be completed on time; instead, learners were told that the temperature will increase when steel wool is wrapped around the thermometer. The teacher indicated that the practical task will be completed some other time. Completed tables formed parts of the assessment in the given worksheet.

Lesson 4, Teacher 4

The lesson began with a summary of the last lesson and Teacher 4 summed up the topic of inter-molecular forces by reminding learners of the topics which he had gone through in the previous lesson. The topics included types of bonds between molecules. The teacher did not involve learners in summarising what they had learned. He then narrated to them what they had covered with him. The teacher gave learners the aim of the activity. Apparatus such as evaporating dishes and four chemicals which included ethanol, water, and nail polish remover methylated spirit and evaporating dishes were provided by the teacher.

Learners were required to record their results in the table. The teacher emphasised that learners did not measure the level of the liquid, but rather just write how much the level had dropped. See vignette below:

Table 4.7: Vignette 4 observations from Teacher 4 classroom practice

Time	Speaker	Text	Observation
12h30-12h32	T4	*"By doing this activity we have to investigate the properties of substances and determine how they relate to intermolecular forces. You investigate evaporation and determine its relationship with intermolecular forces".*	The teacher explained the aims

12h36-12h39	T4	*"Read though the procedures"*	Learners read stated procedure
12h53-13h00	T4	*"We have ethanol here and its dangerous you are not going to handle it I will demonstrate for you"*	The teacher demonstrate the procedure to the learners
13h10-13h15	T4	*"We are going to submit the results of the observations as group, I will mark each group and distribute the marks"*	After the demonstration by the teacher, the learners make deliberations about the activity

The teacher emphasised that substances with weaker intermolecular forces evaporate faster than substances with stronger intermolecular forces. The teacher then took the Petri dishes and put them outside so that he can continue with the lesson. The teacher summarised each activity for learners. Emphasis was on learners to submit their reports for assessment.

4.4 RESULTS FORM DOCUMENT ANALYSIS

Documents that were analysed are teaching plans, lesson plans, and worksheets for practical work and assessment records. Teachers' worksheets of practical work were scrutinised on their design, plan, a structure of the activity and availability. The results showed that teachers do not plan for practical work. Lesson plans that were found in teachers' portfolios were those which have structured questions. Programme of assessments were not available in teachers' portfolios. All teachers had records of marks for formal practical activities which were for promotional purposes. Presented below are the findings from teachers' portfolios and the comments.

Table 4.8: Results from teachers' portfolios

Teacher	Type of document	Proof of practical work
1	Teaching plan	• Does not include practical work, • No annual work schedule for practical work.
	Lesson plan	Two lesson plans for practical work available.
		Lesson plan do not cater for scientific development
	Design of the lesson plan	Demonstration the teacher and learners seated in groups
	Structure of the activity found	• Worksheet with space for learners to fill in their names, topic being studied and aims. • Apparatus are stated. • Steps are shown on how to carry out the activity. A table is given to fill in the distance and time. Questions about the shape of the graph are given and learners write the descriptions. ' • Space is given for learners to conclude on the activity. • Practical work does not promote learners autonomy
	Assessment records	• No assessment plan for practical work • Some of the records of marks for practical work are missing
2	Teaching plan	Available but does not cater for practical work
	Lesson plan	Content lessons available and no lessons for practical work
	Design of the lesson plan	Demonstration by the teacher.

	Structure of the activity found	• The worksheets compose of a space to fill in learners names and the date is indicated and instruction is given. • Learners mix chemical and record initial and final temperatures. They then conclude if the reaction is an exothermic or endothermic reaction.
	Assessment records	• Not available • Available mark sheet is for CASS
3	Teaching plan	Available with plans for practical work.
	Lesson plan	Lesson plans available.
		Lesson plans for practical work are not available.
	Design of the lesson plan	Demonstration the teacher Learners are divided into groups
	Structure of the activity found	• Worksheet with spaces for learners to fill in the information • Aims and list of apparatus are stated, • Method of carrying out the activity shown in pictures • The method is given and learners fill in the table after observations.
	Assessment records	• Assessment plan for practical work is available • Recorded marks are for promotional purposes only
4	Teaching plan	Not available in the portfolio
	Lesson plan	Lesson plan for teaching content are available
		No lesson plan for practical work.
	Design of the lesson	Learner investigation with help from the teacher.

	plan	
	Structure of the activity found	• List of apparatus is given • Aims of the activity are given • Method is stated • A table is given for learners to complete the data • Space for conclusion is given
	Assessment records	• Assessment plan for practical work is not available • Record of learner's marks are for available

4.5 Chapter summary

In this chapter data collected was presented in stages with some interpretations. In stage one (1), data from the interviews were presented. Secondly, data from the observations were supported by vignettes. Lastly, data from the portfolios was described in a tabular form.

The next chapter provides discussions of the findings, recommendations, limitations of the study, areas for future research and conclusions.

CHAPTER 5

DISCUSSION

5.1 Introduction

In this chapter, the researcher presents the discussions and conclusions as informed by the findings of this study while attempting to answer the research questions. Recommendations, implications, limitations of the study as well as areas for future research are discussed.

The purpose of this study was to investigate teachers' perceptions of practical work. The study sought to respond to the following three sub-questions:

- What are Grade 11 Physical Sciences teachers' perceptions about practical work?
- How do Grade 11 Physical Sciences teachers conduct practical work?
- What factors motivate or demotivate Grade 11 Physical Sciences teachers to perform practical work?

5.2 Perceptions of practical work

5.2.1 Mixed perceptions of practical work

The purpose of the study was to explore four Grade 11 Physical Sciences teachers' perceptions of practical work. During the interviews, it was found that all four sampled teachers have mixed perceptions of the concept of practical work (Table 4.1). Both Teacher 1 and Teacher 2 indicated that learners have to observe in the laboratory. They further indicated that learners have to be engaged without specifying the activities for learners. However, this was not evident during the observations of the lessons, because teachers mostly focused on learners producing a report at the end of the lesson. This indicated that teachers thought that when learners submit a report it is regarded as practical work which is an incorrect interpretation of practical work. Similarly, Ramnarain

& Fortus (2013) found teachers have different understandings of the purpose of practical work.

To engage learners, it does not necessarily mean that they are conducting practical work. To Teacher 3, practical work was defined as a tool that is used to develop science knowledge and also as a source of motivation. The teachers' conceptions of practical indicated that they cannot describe the activities that are involved in a good practical work. This was also evident during classroom observations that teaching was not learner centred. The finding suggests that the sampled teachers had a problem with teaching the content they know. This is because practical work in the literature is defined as teaching and learning at which at some point, it involves learners manipulating apparatus (Millar, 2004). Furthermore, practical work is a "hands-on" learning experience (SCORE, 2008, p. 4). In the CAPS document for Physical Sciences, it is stated that practical work in schools should be conducted using the process of scientific inquiry (DBE, 2011) which is when learners conduct investigations.

Sampled Grade 11 teachers' definitions of practical work were based on the way they conduct practical work. This is because it is the teachers' beliefs to do practical work in the school. Furthermore, it was found during the interviews that none of the sampled teachers improvised during their lessons of practical work. This suggests that teachers' belief to the importance of practical work is limited. Teachers' knowledge of process skills is a key element of guiding learners to conduct practical work. However, the process skills were not mentioned form teachers descriptions of practical work.

Teachers were reasoning from their experience and knowledge of practical work with respect to the way they conduct practical work. The study finding corroborates the findings by Mudau and Tabane (2015), who indicated that teachers operated within a faulty framework of what they considered to be practical work. The findings further suggest that teachers have inadequate knowledge of pedagogy because they mentioned that learners are engaged in the task without specifying all the activities of the task to be given to the learners. Their understating was also limited to laboratory

activities only in which Millar (2004) suggested that practical work must not be limited to school laboratory only. However, this is was not a surprise because there was no evidence of sufficient lessons of practical work in teachers' portfolios.

5.2.2 Practical work as demonstration

The analysis of teachers' interviews and classroom observations revealed that the four sampled teachers conducted demonstrations as practical work (Table 4.2). It was also found that one teacher had an understanding of different types of practical work. Demonstration, experiments, investigations and explorative tasks were mentioned as the types of practical work during the interviews. The four sampled Grade 11 teachers revealed that they link the purpose of practical work with the type of practical work they conduct. For example, Teacher 1 mentioned that if the task requires learners to investigate, she would design it such that it allows learners to differentiate between concepts. Heat and temperature were given as examples where learners would differentiate between heat and temperature. However, during detaching and learning it was found that they did not give learners the chance to have the first-hand experience.

The demonstration was key because all the activities began with teacher demonstration. This finding revealed that Physical Sciences was taught only by demonstration with investigation happening by chance. This is in agreement with (Pekmenz, 2005) who reported that teachers preferred to demonstrate because they do not have adequate knowledge of practical work. Similarly, Ituma, Twoli, and Khatete (2015) in Kenya found that 64 % of the teachers they sampled commonly used demonstration to teach Science, despite the benefits of practical work. Furthermore, teaching strategies used by the teachers in practical work did not cater for learners' 'minds-on' activities. This indicated that teachers lacked knowledge of the suitable methods to teach science topics. Similarly, Anza, Bibiso, Mohammad and Kuma (2016) found that among other factors that affect practical work in Chemistry is teacher's poor knowledge of practical work.

The sampled teachers did not have knowledge of methods for teaching science and this encouraged them to use structured activities which Stoffels (2005) referred to as 'cook-book' experiments. Structured experiments disadvantage learners as they will not be problem solvers in the future. Furthermore, Hodson (2014) indicates that teachers should use various science teaching methods because various science aims need various teaching methods.

All four sampled teachers stressed the importance of following the specific aims in the curriculum, however, they did not design tasks that enable learners to achieve science aims. This was also confirmed during the lesson observations that teachers spent most of the allocated time for practical work demonstrating to learners and also coaching them on what was likely to appear in the matric examination theory papers (Kibirige & Mogofe, 2013). The way the teachers conducted practical work was shaped from their perspectives of practical work which indicated that teachers have limited knowledge of curricular of science.

In the CAPS policy document for Physical Sciences, practical work offers learners a chance to investigate. When learners investigate, they engage in the process of investigation. During interviews, teachers stated the importance of practical work as to offer learners a chance to manipulate apparatus, however, learners were not exposed to manipulating apparatus during their learning. However, this was not a surprise because Teacher 1 stressed the types of practical work as demonstrations and experiments during the interviews. The way the teacher conducts practical work has an impact on the learners' learning experience (Sani, 2014). Classroom observations indicated a gap between what was expected in the Physical Sciences curriculum to the actual classroom practices for practical work. Teachers showed a huge participation in the lesson with a low level of learner engagement. Similarly, the lesson plans that were found in teachers portfolios were teacher centred.

The sampled teachers' portfolios revealed that they did not plan for practical work as there was no evidence of lesson plans for practical work in their portfolios. This

suggests that their teaching methods were mostly teacher-centred. Instead, they used formal structured investigations which do not give learners opportunities to think and make their own interpretations of the results. However, it is not the teachers' fault because they are required to conduct standardized practical work from textbooks and teacher guides (Park, Abrahams & Song, 2016).

It was found that the four sampled teachers did not offer learners a chance to manipulate objects. Moreover, the teachers' failure to allow learners to manipulate apparatus in the classroom could mean that they lacked teaching skills and possibly facilitating practical work is a challenge to them. This finding corroborates the studies from Singapore (Kim & Tan, 2011) where practical work is seldom used in classes and it is still a challenge for teachers to reconcile it with an inquiry. Moreover, Benjamin (2004) asserts that the teachers' conduct in the classroom is a reflection of their beliefs about effective teaching. This is in agreement with the findings of the study from Nigeria (Abiodun, Taiwo. Oginni, Aderonke, & Durojaiye, 2013) that there were gaps between teachers' adopted beliefs and their actual classroom practices.

5.2.3 Teachers performing practical work for reporting purposes only

The sampled teachers regarded the purpose of practical work as an assessment tool and they were not motivated to conduct it (Table 4.3). This is because they conducted practical work to satisfy the assessment requirements of the curriculum. It was also found that they conducted formal practical work and informal practical work was not conducted. Formal practical work was conducted because the policy requires one formal practical work per term for reporting purposes. Similarly, Kibirige & Mogofe (2013) found teachers misinterpreted CAPS policies on practical work, also they conducted two practical tasks for CASS purposes. Furthermore, Teacher 1 indicated that she was pushed to conduct practical work because the Head of Department of the school would need marks of the practical activity for assessment purposes. However, this was not a surprise, because the mark sheets that were found in the sampled teachers' portfolios only had marks for the formal tests and practical tasks.

It was also found that teachers do not assess learners' practical skills during practical activities. They mainly focused on written submissions of reports in groups, which is a way that practical work can be done and it was confused with the type of practical work (Mudau & Tabane, 2015). Teachers preferred to give learners formal practical work and award marks for the whole group. The awarded marks for the whole group would reflect the learners' practical mark at the end of the term. This suggests that also passive learners would get marks for the task they did not carry out. Practical work was conducted to satisfy content outcomes. Furthermore, marksheets were found in teacher portfolios had only marks for one assessment task. This indicated that teachers have a partial understanding of CAPS Physical Sciences policy on assessment because they complied with one formal practical work per term and they ignored other informal practical work.

Teachers gave various reasons why they conduct practical work in the way they do. They mentioned that lack of resources obstruct them from carrying-out decent practical tasks and this is confirmed by Motlhabane (2013) who indicated that the conditions in secondary schools are not adequate to carry out doing practical work. They also mentioned lack of time because they are also allocated other grades to teach. Teachers indicated that while informal practical work is written in the policy document, more emphasis is on content since learners are to write a common examination. They suggested that informal practical work does not have time allocation in the pacesetters.

5.3 Recommendations

The findings of the study from the four sampled teachers regarding practical work in Science are not in line with the CAPS curriculum. Teachers have mixed perceptions of practical work which influence how they conduct practical work. Teachers do not conduct informal practical work. Based on the findings and analysis, the following recommendations are offered in order to improve the quality and ways of conducting practical work within the CAPS curriculum.

- In-service training of teachers is needed in order to equip teachers with necessary skills to conduct effective practical work;
- It is recommended that the Department of Education together with subject specialists continue to develop teachers' Pedagogical Content Knowledge through in-service training;
- It is also recommended that the continuing three to four days workshops should be extended since they are not effective in developing teachers PCK. Teachers need to be developed on how to carry out good practical work without depending on the structured activities from the textbook;
- The DOE should assist in ensuring that the educators appointed to teach Science subjects are trained teachers who are specialists. This would ensure that the employed science personnel would carry out the curriculum requirements as required in the curriculum;
- It is recommended that the DOE should increase the number of professional development workshops because the professional development support is not well monitored;
- The DOE should assist teachers financially to improve their subject content knowledge in Science by paying their long or short developmental courses;
- The DOE should assist schools with resources to conduct practical work;
- It is recommended that the Department of Education should design a strategy for calculating the post-provisional norm (PPN) for schools particularly for Science and other demanding subjects. Schools which offer Physical Sciences should be assisted with laboratory materials and also laboratory assistants;
- The circuit should encourage staff exchange programmes so that new and old teachers can learn some of the best practices to conduct practical work;
- Schools should ensure that they have a time-table for practical work so that teachers can conduct informal practical tasks; and
- Finally, it is recommended that teachers should research on different methods for teaching Science topics so that they do not rely on structured activities.

5.4 Limitations of the study

The aim of the study was to investigate teachers' perceptions of practical work. The study was carried out with only four participants from one circuit, therefore, the findings cannot be generalised to the whole circuit or the province. However, the study provided some insight into teachers' perceptions and how they perform practical work.

Language limited the study because participants were given a chance to respond in the language of their choice. Teachers were given an opportunity to switch from English to Sepedi. I translated from Sepedi to English, which limits the study. Some of the meaning may have been lost during translation.

Finally, this study focused on teachers of schools that had adequate Science apparatus.

5.5 Areas for future research

If a similar study is to be conducted, the researcher can research the following areas

- The researcher can conduct the same study but with a larger number of participants in the circuit or from different circuits or regions;
- The period of observation and interviewees can be increased so that even teachers' form schools without apparatus can be observed;
- A similar study can be carried out with classes in the lower grades of Physical Sciences; and
- A similar study with similar design can be carried out involving learners in science subjects learning practical work through electronic or through simulations.

5.6 Conclusion

It is clear that the teachers in this study did not have a clear understanding of practical work, and they could not carry out practical work as recommended in the CAPS curriculum. Lack of resources and time constraints are still a challenge in schools, and

teachers associated them with demonstrations as well as structured practical tasks. Teachers' lack of pedagogical content knowledge is a determining factor that enables teachers to carry out good practical work; therefore teachers need to be developed. Also, Kind (2009) suggest that we should adopt a transformative model of PCK, for initial training for new teachers or in situations in which experienced teachers are learning to teach new subjects.

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APPENDIX A: INTERVIEW SCHEDULE FOR GRADE 11 PHYSICAL SCIENCES TEACHERS

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Research Questions

The research questions that would drive the study are:

- What are Grade 11 Physical sciences teachers' perceptions about nature and purpose of practical work?
- How do Grade 11 Physical sciences teachers conduct practical work?
- What factors motivate Grade 11 Physical sciences teachers to conduct practical work?

Interview questions

1. **What is practical work**

- Can you briefly explain to me what practical work means to you?
- What kinds or types of practical work do you know?
- From the kinds or types of practical work that you have mentioned above, which ones do you use in your teaching of Grade 11 Physical Sciences learners?
- Why do you prefer that particular kind (type) of practical work?
- What are the types of practical work you have conducted so far?
- How often do you conduct practical work?

2. **Purpose of practical work**

- What would you say is the purpose of practical work in teaching and learning?
- Comment on the suggestion that practical work can be used to explain theories and laws of physical sciences
- Do you link the purpose of practical work with the type of practical work that you will be conducting during a lesson?
- If yes, how?
- If no, explain why not.

3. **How you conduct practical work**

- When your learners conduct practical work, what outcomes/ aims do you want them to achieve? Elaborate
- Did you achieve the aims you intend to achieve? Explain

- What were the outcomes of your practical work?
- How many practical tasks or projects did/do your learners perform?
- Can you explain why did your learners perform the number of practical work tasks you have indicated?
- Do you think that your perception/understanding you have about practical work has influenced the way practical work was conducted during you lesson? Explain.
- What factors motivate you to conduct practical work in your classroom?

APPENDIX B: OBSERVATION SCHEDULE FOR PHYSICAL SCIENCES

OBSERVATION SCHEDULE FOR PHYSICAL SCIENCES

School: _____

Date: _____ Topic: _____

Duration of lesson: _____ Venue: _____

Number of learners: _____ Observation no.:_____

Objective in general terms	Tick one box to indicate main objective	Learning objective (more specifically)	Tick one box
A: By doing this activity, students should develop their knowledge and understanding of the natural world.		Students can recall an observable feature of an object or material or event	
		Students can recall a 'pattern' in observations (e.g. a similarity, difference, trend, relationship)	
		Students can demonstrate understanding of a scientific idea, or concept, or explanation, or model, or theory	
B: By doing this activity, students should learn how to use a piece of laboratory equipment or follow a standard		Students can use a piece of equipment, or follow a practical procedure, that they have not previously met	

practical procedure		Students are better at using a piece of equipment, or following a practical procedure, that they have previously met	
C: By doing this activity, students should develop their understanding of the scientific approach to enquiry		Students have a better general understanding of scientific enquiry	
		Students have a better understanding of some specific aspects of scientific enquiry	

Specific aspects of scientific enquiry	Tick all that apply
How to identify a good investigation question	
How to analyse data to reveal or display patterns	
How to plan a strategy for collecting data to address a question	
How to draw and present conclusions based on evidence	
How to choose equipment for an	

investigation	
How to assess how confident you can be that a conclusion is correct	
How to present data clearly	

2. DESIGN	
2.1 Openness/closure	**Tick all that apply**
Question given, and detailed instructions on procedure	
Question given, and outline guidance on procedure; some choices left to students	
Question given, but students choose how to proceed	
Students decide the question and how to proceed	

2.2 Logical structure of the activity	**Tick all that apply**
Collect data on a situation, then think about how it might be summarised or explained	
Use your current ideas to generate a question or prediction; collect data to explore or test	
Other. Please describe	
2.4. What students have to do with objects and materials	**Tick all that apply**
Use an observing or measuring instrument	
Follow a standard practical procedure	
Present or display an object or material	
Make an object	
Make a sample of a material or substance	

Make an event happen (produce a phenomenon)	
Observe an aspect or property of an object, material, or event	
Measure a quantity	
2.5 What students have to 'do' with ideas	**Tick all that apply**
Report observations using scientific terminology	
Identify a similarity or difference (between objects, or materials, or events)	
Explore the effect on an outcome of a specific change (e.g. of using a different object, or material, or procedure)	
Explore how an outcome variable changes with time	
Explore how an outcome variable changes when the value of a continuous independent variable changes	
Explore how an outcome variable changes when each of two (or more) independent variables changes	
Design a measurement or observation procedure	
Obtain a value of a derived quantity (i.e. one that cannot be directly measured)	
Make and/or test a prediction	
Decide if a given explanation applies to the particular situation observed	
Decide which of two (or more) given explanations best fits the data	
Suggest a possible explanation for data	

PRESENTATION	
3.1 How is the purpose, or rationale, communicated to students?	**Tick all that apply**
Activity is proposed by teacher; no explicit links made to previous work	
Purpose of activity explained by teacher, and explicitly linked to preceding work	
Teacher uses class discussion to help students see how the activity can help answer a question of interest	

Purpose of activity readily apparent to the students; clearly follows from previous work	
Activity is proposed and specified by the students, following discussion	
3.2 How is the activity explained to students?	**Tick all that apply**
Orally by the teacher	
Written instructions on OHP or data projector	
Worksheet	
(All or part of) procedure demonstrated by teacher beforehand	
3.3 Whole class discussion before the practical activity begins?	**(Tick all that apply)**
None	
About equipment and procedures to be used	
About ideas, concepts, theories, and models that are relevant to the activity	
About aspects of scientific enquiry that relate to the activity	
3.4 Whole class discussion following the practical activity?	**(Tick all that apply)**
None	
About confirming 'what we have seen'	
Centred around a demonstration in which the teacher repeats the practical activity	
About how to explain observations, and to develop conceptual ideas that relate to the task	
About aspects of investigation design, quality of data, confidence in conclusions, etc.	
3.5 Students' record of the activity	**(Tick all that apply)**
None	
Notes, as the student wishes	

A completed worksheet	
Written report with a given structure and format	
Written report in a format chosen by the student	

APPENDIX C: DOCUMENT ANALYSIS CHECKLIST

Items to be checked and analysed as documented	**YES**	**NO**	**Explanation of the analysed item**
Is there an annual planned schedule for practical work that learners are to			

tackle in the work schedule?			
Is there any evidence of educators' plan to get learners involved in learner designed and directed investigations from teaching plan and lesson plans?			
Does the lesson plan give learners chance to formulate the purpose of the scientific investigation?			

Facilitation Roles: Is there an indication of educators' plan in the educators' portfolios to carry out the facilitation roles such as leading and guiding learners in:			
Setting investigation questions			
Formulating hypotheses			
Identifying and controlling variables			
Designing data collection instruments and methods			
Data interpretation and presentation in varied forms			
Communication of findings			
Argumentation and discourse			
Reflection on scientific investigation			

plans, designs processes in order to identify strengths and weaknesses.			
Evaluation of data collection instruments and methods for validity and reliability.			

Assessment plan:			
Is there evidence of assessment of scientific process skills in performance based assessment tasks?			
Is there evidence of assessment of practical work in test-based performances			
Is there any provision in educators' plan to give support to learners who show some weaknesses in acquisition of scientific process and cognitive skills in scientific investigations?			
Is there any acknowledgement of contextual factors which pose a challenge to the process of practical work?			
Is there any evidence of planned survival strategies to counteract the contextual factors in educators' portfolios?			
Is there evidence of educators' reflection on their classroom			

activities?			

Learners' portfolios

Items to be analysed in learners portfolios	**YES**	**NO**	**Explanations of items analysed**
Are records of practical activities tasks that learners tackled kept in the learners' portfolios?			
Learners' roles in practical activities: Are learners involved in			
Learner initiated and directed practical work?			
Setting investigation questions?			
Formulating hypotheses?			
Identifying and controlling variables?			
Designing data collection instruments and methods			
Data interpretation and presentation in varied forms?			
Communicating of findings?			
Argumentation and discourse?			
Evaluating data collection instruments and methods for validity and reliability?			
Assessment tasks recorded in learners' portfolios			
Are there records of practical			

activities that were assessed in learners' portfolios?			
Is there evidence of learners' progress in the scientific process skills assessed as indicated above?			
Do test-based assessment tasks assess scientific investigative skills?			

APPENDIX D: LETTER TO THE PRINCIPAL REQUESTING PERMISSION TO CONDUCT RESEARCH AT THE SCHOOL

Letter to the Principal Requesting Permission to Conduct Research at the School

P.O BOX 2324
SEGOPJE
0744

Dear Sir/Madam

My name is Mokholwana David Maponya. I am a teacher at Tubake Secondary School. I am a Masters Student studying at the University of Limpopo. I would like to ask for permission to interview and collect data from your Grade 11 Physical science teacher for my Masters of Science research project. I have chosen the following topic for my field of research: A case study exploring Grade 11 Physical Sciences teachers `perceptions of practical work. I will not interrupt the normal running of the school.

My task if permission is granted would be to collect data from the official documents like learners' practical work reports and interview the teacher when he is available. The data collected will be treated with confidentiality. The names of the teacher and your school will not be used in the analysis of the data.

The teacher who will be part of the study will benefit from the enlightenment that will arise from the data. The investigation will not only benefit me as the researcher. I hope you find understanding from the above and grant me the permission to do the research

Cell: 076 355 9648
Work: 0822035457 and ask for Maponya M.D
Email: mokholwana22692@gmail.com

Do not hesitate to contact me for any correspondents arising from this letter

Yours faithfully

Maponya M.D

Consent form

I _____ the headmaster/principal of _____school hereby give consent to Maponya M.D to involve the Physical Sciences grade 11 teacher in his investigation.

Signature: _____ Date: _____

APPENDIX E: LETTER TO THE GRADE 11 PHYSICAL SCIENCES TEACHER

P.O BOX 2324
SEGOPJE
0744

Dear colleague (Grade 11 science teacher)

My name is Mokholwana David Maponya. I am a teacher at Tubake Secondary School. I am a Masters Student studying at the University of Limpopo. As part of the fulfilment of the Master of Science degree I am expected to produce a research report. I have chosen the following topic for my field of research: A case study exploring Grade 11 Physical Sciences teachers `perceptions of practical work.

Using teachers as participants the research aims to answer the following questions

- What are Grade 11 Physical sciences teachers' perceptions about nature and purpose of practical work?
- How do Grade 11 Physical sciences teachers conduct practical work?
- What factors motivate Grade 11 Physical sciences teachers to conduct practical work?

I would like you to be part of my study. I will collect the data from your official documents, non-participant classroom observations and interview you. The report from the data will be solely for the fulfilment of the degree requirements and presentation from the research can also be made in conferences only.

Your names will remain confidential and anonymous. You will receive feedback on the research process. At times, you will be asked to respond to transcripts of interviews to verify and confirm the responses given during the interview. You will gain tremendously from the investigation. The teacher participation will be for the duration of +/- 4 weeks.

I am looking forward to your response as soon as possible. Do not hesitate to contact me for any comment or question arising from this request. You can contact me at:

Cell: 076 355 9648
Work: 0822035457 and ask for Maponya M.D
Email address: mokholwana22692@gmail.com

Yours faithfully

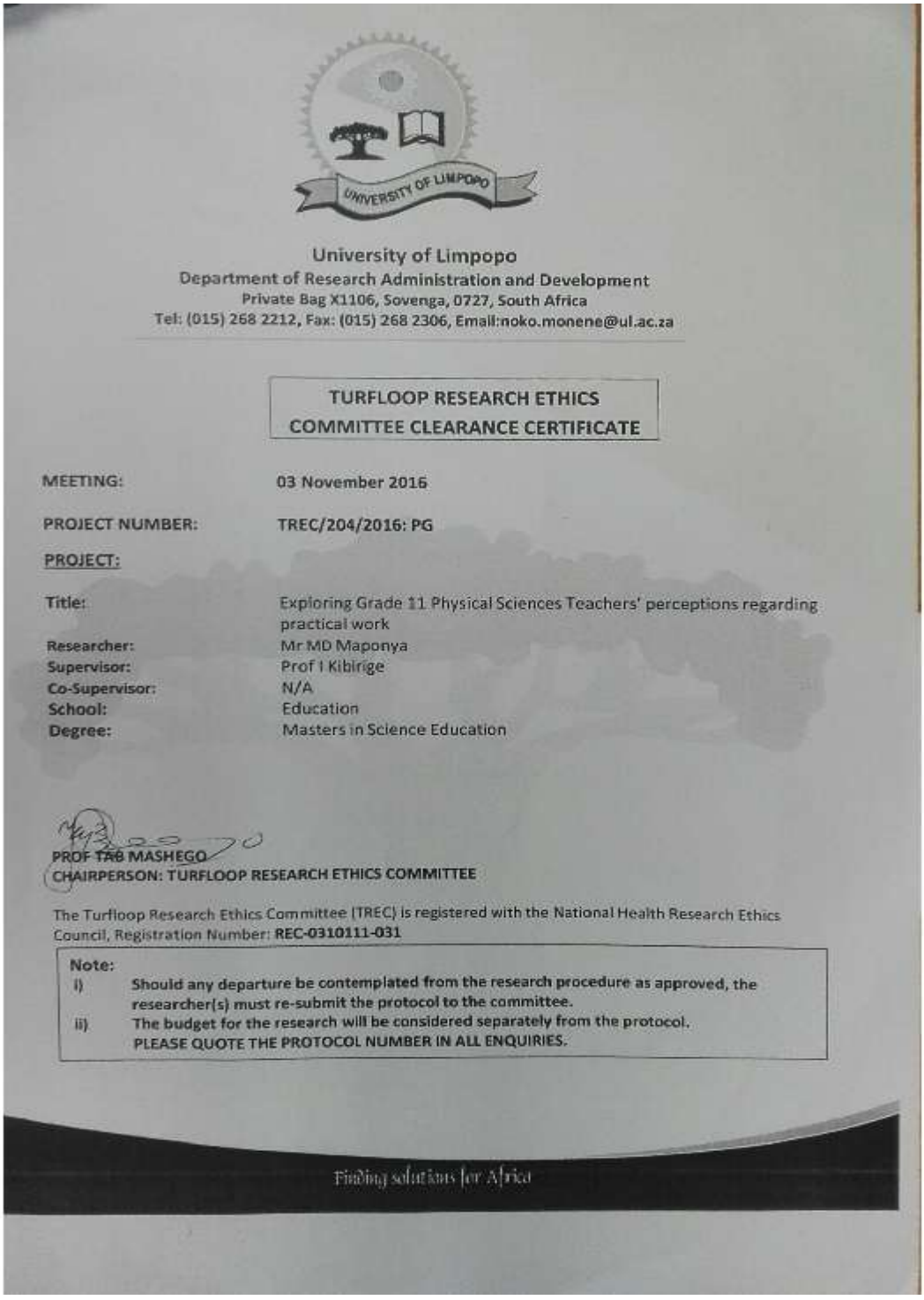
_____
M.D MAPONYA

Consent form for the teacher

I _____ the teacher at _____school hereby give consent to Mokholwana David Maponya to be part of his investigation. However the data that will be collected from me and my class should be used for the research presented to me by Maponya M.D and conferences only. I understand that my real name will not be used in any aspect of the write-up of the study. I am also aware that I am not obliged to answer all the questions and may feel free to withdraw from the study at any point.

Signature: _____ Date: _____

APPENDIX F: LETTER FROM THE UNIVERSITY OF LIMPOPO



University of Limpopo
Department of Research Administration and Development
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 2212, Fax: (015) 268 2306, Email:noko.monene@ul.ac.za

TURFLOOP RESEARCH ETHICS COMMITTEE CLEARANCE CERTIFICATE

MEETING:	**03 November 2016**
PROJECT NUMBER:	**TREC/204/2016: PG**
PROJECT:	
Title:	Exploring Grade 11 Physical Sciences Teachers' perceptions regarding practical work
Researcher:	Mr MD Maponya
Supervisor:	Prof I Kibirige
Co-Supervisor:	N/A
School:	Education
Degree:	Masters in Science Education

PROF TAB MASHEGO
CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: **REC-0310111-031**

Note:
i) **Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee.**
ii) **The budget for the research will be considered separately from the protocol.**
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

Finding solutions for Africa

APPENDIX G: LETTER FROM THE DEPARTMENT OF EDUCATION

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

Ref: 2/5/6/1 Enq: MC Makola PhD Tel No: 015 290 9448 E-mail: MakolaMC@edu.limpopo.gov.za

Maponya M.D
P.O BOX 2324
SEGOPJE
0744

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

1. The above bears reference.
2. The Department wishes to inform you that your request to conduct research has been approved. Topic of the research proposal: **"A CASE STUDY EXPLORING GRADE 11 PHYSICAL SCIENCES TEACHERS 'PERCEPTIONS OF PRACTICAL WORK."**
3. The following conditions should be considered:

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

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

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

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

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

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

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

Request for permission to Conduct Research: Maponya M.D

CONFIDENTIAL
Cnr. 113 Biccard & 24 Excelsior Street, POLOKWANE, 0700, Private Bag X9489, POLOKWANE, 0700
Tel: 015 290 7600, Fax: 015 297 6920/4220/4494

The heartland of southern Africa - development is about people!

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

Best wishes.

31/03/2016

MUTHEIWANA NB
HEAD OF DEPARTMENT (ACTING)

DATE

Request for permission to Conduct Research: Maponya M.D

CONFIDENTIAL

APPENDIX H: LETTER TO CIRCUIT MANAGER

MAPONYA M.D
P.O BOX 2324
SEGOPJE
0744

TO: THE CIRCUIT MANAGER
LIMPOPO DEPARTMENT OF EDUCATION
MANKWENG CIRCUIT
DATE: 05 MAY 2016

SUBJECT: PERMISSION TO CONDUCT RESEARCH: MAPONYA M.D

Dear Sir/Madam

My name is Mokholwana David Maponya. I am a teacher at Tubake Secondary School. I am a Masters Student studying at the University of Limpopo. I would like to ask for permission to collect data from two Grade 11 Physical Sciences teachers for my Masters of Science research project. I have chosen the following topic for my field of research: **A case study exploring Grade 11 Physical Sciences teachers `perceptions of practical work**. I will not interrupt the normal running of the school.

I would like to conduct my research in Mankweng Circuit of the Capricorn district. My wish is to conduct my research in the second term of 2016. My task if permission is granted would be to collect data from the official documents like learners' practical work reports and interview the teachers when he/she is available. The data collected will be treated with confidentiality. The names of the teacher and the school will not be used in the analysis of the data.

Kindly forward your permission to me on the email address listed below. Your swift response in this letter is greatly appreciated.

Cell: 076 355 9648 or 084 747 3226

Work: 082 203 5457 and ask for Maponya M.D

Email: mokholwana22692@gmail.com

Do not hesitate to contact me for any correspondents arising from this letter

Yours faithfully
Maponya M.D

APPENDIX I: Interview transcript TEACHER 1

Line no	Interview transcript
1	**What is practical work**
2	R: thank you very much mam for allowing me to interview you. During the
3	interview, if you don't understand any question you are allowed to ask me
4	to elaborate further. In this interview there is no correct or wrong answer. I
5	am kindly asking you to answer the questions to your best ability. The
6	questions are based on practical work, your understanding of practical
7	work, how you conduct it and its purpose. Now let's move on to the first
8	question. Can you briefly explain to me what practical work means to you?
9	R. err ehh…. So you mean any practical work or in science? (R. I mean in
10	science), mmm….. Ok practical work is when learners observe and see
11	things. Leaners hold material and they observe anything that we are doing
12	in the laboratory. They observe while they are investigating laws. It is like,
13	they investigate things in science as you know scientists are always
14	investigating.
15	R: thank you mam what kinds of practical work do you know?
16	H: I know experiment and demonstration. mmm… yah that's all
17	R: So, which ones have you conducted?
18	T1: I have performed demonstration and experiments with my learners.
19	Now this is because as you can see we have laboratory but the apparatus
20	are not enough. I demonstrate on that table (pointing the table positioned
21	in front of the table) and then my leaners follow from the demonstration. I
22	do this as a precaution because my learners can hurt themselves.
23	R: if I may ask why do you prefer demonstration and experiments?
24	T1: like I said, it helps learners to understand further, I won't have time to
25	supervise all of them, they are many. If I demonstrate, they can know the
26	process and they follow it. So I demonstrate once if the task is not too
27	long.
28	R: What are the types of practical work you have conducted so far?
29	T1: we have conducted demonstration, investigation and experiment.

30 31 32	R: How often do you conduct practical work T1: To be honest with you Mnr, I only do the practical work when we report for per assessment guideline. Leaners are given handouts and they fill in the information. But sometimes I do demonstration because my class is too big to perform and experiment with all of them.
33	**Purpose of practical work**
34 35 36 37 38 39 40 41 42 43 44 45 46 47	R: What would you say is the purpose of practical work in teaching and learning? T1: Practical work help learners not to forget the things they are doing. It also help them to explore the scientific process. Leaners do not forget easy when they do things practically. Sometimes it helps leaners to enjoy science. R: mmm ok, so Do you think we can use practical work to explain theories and laws of physical science? T1: uhm yes we can. (May you please elaborate further) We integrate science so that laws can be explained further. R: do you link the purpose of practical work with the type of practical work that you will be conducting? T1: Yes I do, because if I want my leaners to investigate, then I would design a task that allows them to investigate. If I want then to differentiate between heat and temperature I would let them experiment it but with precaution so that they don't burn themselves.
48 49 50 51 52 53 54 55 56	**How practical work is conducted** R: when your learners conduct practical work what or which CAPS aims do you want them to achieve? T1: uhm, there are general aims and science aims. I always want my learners to observe, be able to work in groups and basically be able to write a report. In some cases it is based on the task of the day. I mean the one that we will be doing, either formal or informal. R: Do you often achieve the aims you intend to achieve? T1: yes I do. (Please elaborate on that, R). As you can see, they wrote a

57	report, so that is another aim that is achieved. They worked in groups.
58	R: How many practical tasks learners perform?
59	T1: My learners did six practical tasks
60	R: Can you explain why did your learners perform the number of practical
61	work tasks you have indicated?
	T1: uhm you see, firstly we have a challenge of resources. I try by all means to remain with the learners but it's too much. The money allocated
62	on the norms is not enough to subsidise us. We can't but other resources.
63	R: Do you think that your perception/understanding you have about
64	practical work has influenced the way practical work was conducted
65	during you lesson?
66	T1: uhm, well practical work is conducted to engage learners and to
67	improve their understanding, so I design it in such a way that it helps they
68	to learn.
69	R: What factors motivate you to conduct practical work in your classroom?
70	I always want my leaners to be best performers, so that I why I conduct
71	practical work. I also do it mainly for marks.
72	R:do you have any other thing that you would like to add on practical work
73	T1: I booked a laboratory in the varsity so you may also come and
74	observe or help us because in some cases I am not sure if m doing the practical correctly.

APPENDIX J: Interview transcript TEACHER 2

Line no	**Teacher 2**
1	What is practical work
2	R: thank you very much sir for allowing me to come and interview you in
3	this buys schedule. In this interview there is no wrong or correct answer.
4	You may provide answers to the best of your ability. If there is one
5	question that you don't understand please don't hesitate to stop or tell me
6	to repeat the question. The questions are divided into three main
7	categories, and the first one is about what practical work, its purpose is
8	and how you conduct it. Please don't regard this as threatening or a way
9	of finding any of your wrong doings. This is a normal interview and not a
10	witch-hunt to report to the department of education or any stakeholder.
11	Now, were moving to the first category of interviews, what is the practical
12	work
13	T2. Err thank you very much sir, according to my understanding, practical
14	work is an investigation where learners are engaged. R: so what do you
15	mean by learners being engaged? T2: learners are in the laboratory
16	holding apparatus and manipulating them to get answers to their learning
17	activity. You know, they are working in the laboratory doing experiments
18	with me.
19	R: thank you sir: what kinds of practical work do you know?
20	T2: errr I know problem solving, practical tasks, skills practical,
21	observational, investigation and explorative tasks.
22	R: So, from the ones you have mentioned above which ones have you
23	conducted in class?
24	T2: err we did investigations and explorative tasks where learners
25	observe.
26	R: if I may ask why do you prefer the investigation
27	T2: mmm you see when learners investigate, it helps learners to
28	understand scientific concepts or principles better.
29	R: What are the types of practical work you have conducted so far?

30	T2: mmm we did investigations and explorative tasks R: How often do you conduct practical work T2: err we conduct it twice in a quarter. So if we sometimes go to the university of Limpopo to conduct other practical tasks
33	**Purpose of practical work**
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56	R: What would you say is the purpose of practical work? T2: Practical work expose learners to many things. Practical work help to develop learners' practical skills. It also enables learners to solve problems and scientific concepts. They observe and take measurements which helps them to learn science better. R: Do you think we can use practical work to explain theories and laws of physical science? T2: err yes….I think practical work can be used to explain practical work theories. But it is some theories that we can prove in class. For example, in electricity we can demonstrate laws but you know some of the practical work we can't do it in schools. We have limited materials and you see our laboratory is not well equipped. R: do you link the purpose of practical work with the type of practical work that you will be conducting? T2: Yes I do. R: Because you said yes can you elaborate further…… T2: err, (long pause) eish, you see if I want my learners to investigate, I will lead them to a task that enables them to investigate very well and if they do it, it will be after I have demonstrated. Because you know we work on a very limited time, I sometimes book them a laboratory in the University of Limpopo and they help us there. I do this if I have a challenge with the task. R: do you think practical work can be used to explain process skills in science? Err yes, now you see if I want to engage my leaners in the process, I actually show them that we follow a process that will ultimately show them

	that there is a process to be followed. They can observe and write reports.
57	**How practical work is conducted**
58	R: when your learners conduct practical work what CAPS aims do you
60	want them to achieve?
61	T2: you see time is not on our side. But what I want is similar to that of
62	CAPS. CAPS put it clear that we are teaching, we should try to use
63	practical work so that it help learners to understand better. CAPS put it
64	clear that we must equip this learners with investigating skills and if we do
65	investigation it helps them to investigate better. When they conduct
66	investigation they also develop problem solving skills. For example if I
67	give them a task and they find the hypothesis or they derive the questions
68	to pursue then they can be able to solve the problems. Again, when
69	learners organise, data and work in groups then I know I pursue some of
70	the general aims. The other am is to acquire practical skills.
71	R: Do you achieve the aims you intend to achieve?
72	T2: yes I do. (Please elaborate on that, REA). Uhm you see my learners
73	were in grouped together. Now this is also in the aims. My learners were
74	able to identify the apparatus, they were able to carry out the task as
75	required, they wrote all the steps, they recorded every detail of the
76	practical, and in fact they compiled a report about the task. They were
77	also able to make interpretation from the results. So in that way, I can
78	definitely say I was able to clearly achieve what I wanted them to achieve.
79	R: How many practical tasks learners perform?
80	T2: My learners did three experiments or practical per quarter.
81	R: Can you explain why did your learners perform the number of practical
82	work tasks you have indicated?
83	T2: uhm you see, firstly we have a challenge of resources, and even the
84	ones were using them were borrowed from out neighbouring school.
85	Secondly we don’t have enough time. I teach grade 11 and I also have
86	other classes to teach. All my classes on the time table need my full
87	attention in all.

88 89 90	R: Do you think that your perception/understanding you have about practical work has influenced the way practical work was conducted during you lesson?
91 92 93 94 95	T2: uhm, well I can say practical work should be conducted in area where is it triggering learners' interests. I mean the area where learners' interest can be captured. I created an area in my class were leaners are engaged. So I think because practical work has to be intriguing, I created that platform for my learners.
96 97 99 100 101	R: What factors motivate you to conduct practical work in your classroom? Err I may say when I conduct practical work I what my leaners to be engaged. I want my learners to be hands on. I want my learners to develop investigating skills, I want my leaners to be able to concentrate on what I am teaching about and they will also be focusing.
102 103	R: do you have any other thing that you would like to add on practical work
104	T2: mm you see, I would say we need more laboratories that have well equipped materials. The laboratories we have do not have all the resources we need to work. And we have a lot of work to do, so in some cases we need assistants to help with this practical work because we spend most of our time teaching other classes and when you go to laboratory, you are already tired.

APPENDIX K: Interview transcript for Teacher 3.

Line no	Interview transcript for Teacher 3.
1	**What is practical work**
2	R: thank you very much mam for allowing me to come and interview you
3	in this busy schedule. In this interview there is no wrong or correct
4	answer. You may provide answers to the best of your ability. If there is
5	one question that you don't understand please don't hesitate to stop or tell
6	me to repeat the question. The questions are divided into three main
7	categories, and the first one is about what practical work, its purpose is
8	and how you conduct it. Please don't regard this as threatening or a way
9	of finding any of your wrong doings. This is a normal interview and not a
10	witch-hunt to report to the department of education or any stakeholder.
11	Now, were moving to the first category of interviews, what do you
12	understand by the term practical work?
13	T3. Err thank you very much sir, according to my understanding, practical
14	work is a task that develops learners understanding of science. It
15	enhances learners' scientific knowledge and motivate pupils by
16	stimulating their interest. For example, in my case we have many learners
17	doing science because of this this practical tasks.
18	R: thank you, so what kinds of practical work do you know?
19	T3: err they are problem solving, experiment and observational task. Err
20	(long pause) I may also add investigations and maybe projects
21	R: So, from the ones you have mentioned which ones have you
22	conducted your learners?
23	T3: uhm we did investigations and experiments
24	R: if I may ask why do you prefer the investigation and experiments
25	because those are ones you have mentioned?
26	T3: uhm they help leaners to understand science better. So I may also
27	say it also engage learners in the task. I mean you will see that leaners
28	are engaged in the task. Experiments mmm I can say they offer learners a
29	chance to experiment the real process of science. We have Saturdays

30	were we come to do experiments.
31	R: What are the types of practical work you have conducted so far?
32	M: uhm investigation and experiments
33	R: How often do you conduct practical work
34	T3: if we are lucky we perform two practical task per month. I demonstrate
35	those tasks because of time. And I also use this just to help learners
36	understand. We also performed three main practical task in the laboratory. When I say three main is because we are required to report with one main practical work per term. We have 1 formal task per term and other informal practical tasks.
37	**Purpose of practical work**
38	R: What would you say is the purpose of practical work?
39	T3: it develops learners' skills. It also help learners to solve science
40	problems and also in their real life. Practical task keep learners focused
41	by observing and filling in the handouts which are reports.
42	R: Do you think we can use practical work to explain theories and laws of
43	physical science?
44	T3: err yes, (may you please elaborate further, R) mmmm…. learners get
45	to integrate their daily experiences in class.
46	R: do you link the purpose of practical work with the type of practical work
47	that you will be conducting?
48	T3: Yes I do.
49	R: Because you said yes can you elaborate further
50	T3: err, (long pause) I integrated practical work in my lessons, so if I want
51	leaners to be engaged they will do investigations.
52	R: do you think practical work can be used to explain process skills in
53	science?
54	Yes: the process skills are very important to leaners. If my leaners are writing a report they can learn how to make predictions and hypothesises then I know they have developed process skills.
55	**How practical work is conducted**

56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83	R: when your learners conduct practical work what CAPS aims do you want them to achieve? T3: I want them to acquire practical skills. I also want them to understand scientific skills. R: Do you achieve the aims you intend to achieve? T3: mmm yes I did, my learners found easy to understand the task because it was practical R: How many practical tasks did your learners perform? T3: My learners did three experiments per quarter. R: Can you explain why did your learners perform the number of practical work tasks you have indicated? T3: mmm, they acquire scientific skills to understand the theory in science. They learn understand scientific skills. R: Do you think that your perception/understanding you have about practical work has influenced the way practical work was conducted during you lesson? T3: uhm yes, I wanted to improve my learners understanding so, because I know practical work improves learners understanding I performed it with them. Also it was engaging and helping them to understand science better. R: What factors motivate you to conduct practical work in your classroom? T3: learners get used to practice science and because I want to improve their understanding. I want my leaners to be problem solvers, so practical work enables them to be scientific problem solvers. R:do you have any other thing that you would like to add on practical work T3: I would say, my learners are many so, when I divide them in groups it's still a problem because I have to monitor all the groups in my own. So getting someone to help me in class would be much better. In some instance when we are lucky, we book a laboratory in the university and it helps us a lot with practical because they have laboratory assistants that help in the laboratory during investigations.

APPENDIX L: Interview transcript for Teacher 4

Line no	Interview transcript for Teacher 4
1	**What is practical work**
2	R: thank you very much mam for allowing me to come and interview you
3	in this busy time of the year. In this interview there is no wrong or correct
4	answer. You may provide answers to the best of your ability. If there is a
5	question that you don't understand please don't hesitate to stop or tell me
6	to repeat the question. The questions are divided into three main
7	categories, and the first one is about what practical work is, its purpose
8	and how you conduct it. Please don't regard this as the threatening or a
9	way of finding any of your wrong doings. This is a normal interview and
10	not a witch-hunt to report to the Department of Education or any
11	stakeholder. Now, were moving to the first category to interviews, what do
12	you understand by the term practical work?
13	T4. Thank you sir, mmm… practical work is an investigation that engage
14	learners. Learners are engaged into the practical activity and they do it by
15	themselves or maybe with supervision. Learners investigate and collect
16	results of what is happening, maybe during the observation. They then at
17	the end they produce a report of the observation.
18	R: thank you sir, so what kinds of practical work do you know?
19	T4: I know investigations, experiments, projects and demonstration.
20	R: So, from the ones you have mentioned which ones have you
21	conducted your learners?
22	T4: uhm we did investigations and demonstration
23	R: if I may ask why do you prefer the investigation and demonstration
24	because those are ones you have mentioned?
25	T4: investigations help learners to be best investigators and they learn
26	better. Mmm….demonstrations are time saving in the case where I am
27	rushing to another class. Sometimes I demonstrate because of shortage
28	of laboratory apparatus.

29 30 31 32 33 34 	R: What are the types of practical work you have conducted so far? M: uhm investigation and experiments. We also did the experiment on electricity. R: How often do you conduct practical work T4: we conduct practical work once or twice in a term. But the minimum is one per term. If we conduct one task it will be for CASS. Apart from that, we have few apparatus so to conduct it we need apparats which we don't have. The department does not offer us apparatus it is only a mini-lab with few apparatus.
35	**Purpose of practical work**
36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56	R: What would you say is the purpose of practical work? T4: mmm… the purpose of practical work is to help learners learn best. It help them to learn part of the science better by observing some of the things we do in science. For example the procedures and methods of investigation in the laboratory. Mm... Sometimes practical work expose this learners to meaningful learning and this comes as a result of learners enjoying practical work. R: Do you think we can use practical work to explain theories and laws of Physical Science? T4: Yes we can use practical work to explain theories better. For example, learners were doing ohm s` law practically that, they investigate potential difference with current or resistance or they come the potential differences across resistors. To add to that, we are also teach learners that they need to follow an order to obtain the results. For us to get the formula for calculating resistance, it is a result of a followed process. R: do you link the purpose of practical work with the type of practical work that you will be conducting? T4: Yes I do. R: Because you said yes, can you elaborate further T4: err, (long pause), if the purpose is to investigate, then will do a practical work that they investigate in it.

57	R: Do you think practical work can be used to explain process skills in science? T4: Yes: the process skills are very important to learners. Learners need them to be best scientists. Again, they help learners in the future.
59	**How practical work is conducted**
60	R: when your learners conduct practical work what CAPS aims do you
61	want them to achieve?
62	T4: The curriculum has stipulated aims. When I design my lessons I
63	always put my aims on the aims of the curriculum. The curriculum state
64	that leaners must be able to work as a group, so I sometimes group them.
65	They should also be able to write a report, so at the end of the practical
66	task, they write a report.
67	R: Do you achieve the aims you intend to achieve?
68	T4: yes I do, I always push my learners to achieve the aims of the lesson,
69	but in some cases due to time we do not do all the activities.
70	R: How many practical tasks did your learners perform?
71	T4: My learners did three tasks.
72	R: Can you explain why did your learners perform the number of practical
73	work tasks you have indicated?
74	T4: we do not have apparatus that allow us to do more practical tasks.
75	The amount of money we get for norms and standards is very little, so it
76	does not cover all the necessities. Another thing is time, we do not have
77	to plan and conduct all this practical work with all learners.
78	R: Do you think that your perception/understanding you have about
79	practical work has influenced the way practical work was conducted
80	during you lesson?
81	T4: I plan practical work according to my understanding. I conduct it the
82	way I understand it. I give learners a procedure to follow because I know it
83	is safe to do so.
84	R: What factors motivate you to conduct practical work in your classroom?
85	T4: firstly I am pushed to do practical work in that it is recommended in

86 87 88 89	the assessment plan. Secondly, I conduct practical work because learners enjoy it. R:do you have any other thing that you would like to add on practical work T4: If it was possible I would recommend that the department of education supply us with the apparatus because we only conduct practical work for CASS. We do not have resources and this affect us negatively and we end up demonstrating since we do not have enough apparatus for all learners.

APPENDIX M: observational schedule teacher 1

Observation	**Teacher`s actions in the classroom**	
Aim of the activity	-by doing this activity learners will be determining which objects obey Ohm s law.	Content outcomes
Design of the learning activity	-questions are given out to learners with stated procedure	
Structure of the activity	Learners collect data and record it on the table. The collect data and calculate voltage/current	Process outcomes
Learners handling of apparatus	-learners follow stated procedure when they perform the experiment -They observe and collect results.	
Results and conclusions	-they collect results for resistors -they calculate measure potential difference and current	
Presentation of the activity	-the teacher give learners the aim of the activity -the teacher discuss the aim of the activity with the	

	learners	
Communication of the activity to the learners	-the teacher issue worksheets to leaners -the teacher demonstrate the procedure to the learners	
Whole class discussion before the activity	The teacher discuss handing of apparatus with the learners	
Discussion after completing the activity	-After the demonstration by the teacher, the leaners make deliberations about the activity -They use the graph paper to plot the results	
Learner record the practical activity	-learners complete a given work sheet. -they calculate the resistance using the given formula -they draw a graph of V against I	

APPENDIX N: observational schedule teacher 2

Observation	Teacher`s actions in the classroom	
Aim of the activity	-when doing this activity learner are going to investigate exothermic and endothermic reactions	Process outcomes
Design of the learning activity	-questions are given with instructions -questions ae given to by the teacher and learners select the procedure.	
Structure of the activity	the teacher guide the learners to select apparatus -learners perform the experiment -they observe the experiment They collect results	Process outcomes
Learners handling of apparatus	-learners follow stated procedure when they perform the experiment -They observe and collect results.	
What learners do with statements	-they explore mass with acceleration -they count the number of dots on the ticker timer -they complete the table	

	and plot the graph	
Presentation of the activity	-the teacher give learners the aims of the activity -the teacher suggest possible statements to learners	
Communication of the activity to the learners	-the teacher issue worksheets to leaners -the teacher demonstrate the procedure to the learners	
Whole class discussion before the activity	The teacher discuss handling of apparatus with the learners The teacher demonstrate to the earners how to mix lithium with water	
Discussion after completing the activity	-After the demonstration by the teacher, the leaners make deliberations about the activity -They use the graph paper to plot the results	
Learner record the practical activity	-learners complete a given work sheet.	

APPENDIX O: observational schedule teacher 3

Observation	**Teacher`s actions in the classroom**	
Aim of the activity	-By doing this activity learners investigate the properties of substances and determine how they relate to intermolecular forces. -learners investigate evaporation and determine its relationship with intermolecular forces.	Content outcomes
Design of the learning activity	-the teacher guide learners with stated procedure. -learners observe a closed practical work.	
Structure of the activity	-the teacher guide the learners to select apparatus -learners perform the experiment by following stated procedure	Process outcomes
Learners handling of apparatus	-learners follow stated procedure when they perform the experiment -They observe and record results	
What learners do with statements	-the teacher guide learners to handle apparatus well	

	since some of them are dangerous for example ethanol and methylated spirit -leaners complete the given table of measurements of substances after few minutes.	
Presentation of the activity	-the teacher give learners the purpose of the activity - the teacher explain the aims of the activity	
Communication of the activity to the learners	-the teacher issue worksheets to leaners -the teacher demonstrate the procedure to the learners	
Whole class discussion before the activity	The teacher discuss handling of apparatus with the learners The teacher demonstrate to the learners	
Discussion after completing the activity	-After the demonstration by the teacher, the leaners make deliberations about the activity -They use the graph paper to plot the results	
Learner record the practical activity	-learners write a report from their conclusions	

APPENDIX P: observational schedule teacher 4

Observation	**Teacher`s actions in the classroom**	
Aim of the activity	-By doing this activity, learners will use ticker timer to investigate the relationship between force and acceleration. -Learners will investigate the effect of acceleration when mass is increased.	Content outcomes
Design of the learning activity	-questions are set with given stated procedure -questions are given with stated procedure and learners follow stated procedure	
Structure of the activity	Learners collect data to test a newton second law of motion	Process outcomes
Learners handling of apparatus	-learners follow stated procedure when they perform the experiment -They observe and collect results.	
Results and conclusions	-they explore mass with acceleration -they count the number of dots on the ticker timer -they complete the table	

	and plot the graph	
Presentation of the activity	-the teacher give learners the aim of the activity -the teacher discus the aim of the activity with the learners	
Communication of the activity to the learners	-the teacher issue worksheets to leaners -the teacher demonstrate the procedure to the learners	
Whole class discussion before the activity	The teacher discuss handing of apparatus with the learners	
Discussion after completing the activity	-After the demonstration by the teacher, the leaners make deliberations about the activity -They use the graph paper to plot the results	
Learner record the practical activity	-learners complete a given work sheet.	