

**AN EXPLORATION OF GRADE 11 TEACHERS'
CONCEPTIONS OF PRACTICAL WORK IN PHYSICAL
SCIENCES WITHIN THE NATIONAL CURRICULUM
STATEMENT (NCS) CURRICULUM.**

A Research Report Submitted

by

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TABLE OF CONTENTS

Abstract	v
Declaration	vi
Acknowledgements	vii
List of acronyms	viii
List of Tables	ix
List of Appendices	x

CHAPTER 1: INTRODUCTION TO THE STUDY

1.1	Introduction	1
1.2	Background to the study	1-3
1.3	Rationale for the study	4-5
1.4	Purpose of the study	5-6
1.5	Statement of problem	6-7
1.6	Research design and methodology	7-8
1.7	Significance of the study	8-9
1.8	Chapter summary	9
1.9	Preview of following chapters	9

CHAPTER 2: LITERATURE REVIEW

2.1	Introduction	10
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2.2	Perspectives on practical work	10-13
2.3	Practical work and its place within NCS curriculum	13-14
2.4	The purpose of practical work in science and within NCS curriculum	14-17
2.5	The types of practical work	17-21
2.6	Research on teachers perception of practical work	22-26
2.7	Theoretical framework	26-30
2.8	Chapter summary	30

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1	Introduction	31
3.2	Research design	31-34
3.3	Methodology	35-37
3.4	Participant selection	37-38
3.5	Data collection methods	38-39
3.5.1	Interviews	39-40
3.5.2	Classroom observation	40-41
3.6	Data collection process	41-42
3.7	Data analysis	42-43
3.8	Trustworthiness	43-45
3.9	Ethical issues	45
3.10	Limitations of the study	46
3.11	Chapter summary	46

CHAPTER 4: RESULTS AND DISCUSSION

4.1	Introduction	47 -48
4.2	Case One: Shranda's case	48-57

4.3	Case two: Clara's case	57-66
4.4	Cross-case analysis	66-73
4.5	Conclusion	73-74

CHAPTER 5: DISCUSSION AND CONCLUSION

5.1	Introduction	75
5.2	Teachers' understanding of practical work	74-75
5.3	Teachers' classroom practice	75-77
5.4	Reasons for teachers classroom practice	77-79
5.5	Recommendations	79-80
5.6	Conclusion	80-81
	References	83-88
	Appendices	89-120

ABSTRACT

The introduction of the National Curriculum statement (NCS) in Further Education and Training (FET) phase in 2005 had a great impact on classroom practice, resulting in a shift to Outcomes Based Education (OBE). The Physical Sciences curriculum created challenges for Physical Science teachers. The Learning Outcome (LO)-1 recommends that scientific inquiry and inquiry based practical work be taught in Physical Sciences lessons. However, much remains to be understood regarding teachers' pedagogical content knowledge (PCK) in inquiry based practical work. This study explored the conception of practical work by Grade 11 Physical Sciences teachers within the NCS curriculum. Using the PCK as a theoretical lens, the study explored how the Physical Sciences teachers used practical work in their teaching. Furthermore, the exploration sought to ascertain whether there was any relationship between teachers' perceptions of the purpose of practical work and their use of practical work.

The data was collected by interviewing two Grade 11 Physical Sciences teachers and also by conducting some classroom observations involving practical work to ascertain teachers' actual practice. The sample was drawn from two high schools at Empangeni District, in Northern KwaZulu-Natal. The findings revealed that teachers value using practical work in teaching of Physical Sciences. Qualitative data analysis enables recommendation to be made for the improvement of the use of inquiry-based practical work in the teaching of Physical Sciences. Both teachers held the view that the most important aim of practical work was to promote conceptual understanding. During their teaching, both teachers use practical work to verify theory through non-inquiry practical instructional practices and strategies. However, there were limiting factors which do not provide opportunities for teachers to engage learners in inquiry-based practical work. Amongst the factors that were reported by the teachers as limiting their use of inquiry-oriented practical work are limitations of resources, time constraints, large classes and pressure to complete the prescribed curriculum.

It is recommended that curriculum developers through the use of subject education specialist (SES), facilitate teachers' transformation from expository to inquiry instruction. More discussions on how to design and conduct inquiry-based practical work are recommended.

DECLARATION

I declare that this research report, titled:

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WORK IN PHYSICAL SCIENCES WITHIN THE NATIONAL CURRICULUM
STATEMENT (NCS) CURRICULUM**

is my own effort. It has not been submitted in any form for any degree or diploma to any other tertiary institution. All sources that I have used or quoted have been indicated and acknowledged by means of complete references. It is submitted for the Degree of Masters of Education (M.Ed) in the School of Science, Mathematics and Technology Education, University of KwaZulu-Natal.

Sebenzile H. Ngema

Signed on this -----day of March 2012.

DEDICATION

This work is dedicated to my children **Lungisani, Bongakonke, Sisanda** and my grandchild **Asiphe** as well as my beloved husband **Mr. P.W. Ngema** who provided me with love and support throughout my studies. Their sacrifices and perseverance were a great contribution to my education as a whole. May the Almighty God always be with my parents for laying the foundation of my success.

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LIST OF ACRONYMS

ASs	:	Assessment Standards
FET	:	Further Education and Training
GET	:	General Education and Training
HOD	:	Head of Department
LO	:	Learning Outcome
NCS	:	National Curriculum Statement
OBE	:	Outcomes Based Education
PCK	:	Pedagogical Content Knowledge
STD	:	Secondary Teachers Diploma
SES	:	Subject Education Specialist

LIST OF TABLES

Table 2.1	:	Classification of activities by their objectives
Table 2.2	:	Profile of implementation

LIST OF APPENDICES

Appendix A1	:	Pre-interview schedule
Appendix A2	:	Post-interview schedule
Appendix B	:	Classroom observation schedule
Appendix C1	:	Letter from KZN Department of Education
Appendix C2	:	Letter to the teacher
Appendix C3	:	Letter to the principal
Appendix D	:	Ethical clearance certificate
Appendix E1	:	Pre-interview transcript for Shranda
Appendix E2	:	Post-interview transcript for Shranda
Appendix E3	:	Pre-interview transcript for Clara
Appendix E4	:	Post-interview transcript for Clara
Appendix F1	:	Classroom observation notes for Shranda
Appendix F2	:	Classroom observation notes for Clara

CHAPTER 1

INTRODUCTION TO THE STUDY

1.1 INTRODUCTION

This chapter introduces a study that has explored Grade 11 Physical Sciences teachers' conception of practical work within the South African new school curriculum, National Curriculum Statement (NCS). This exploration focused on Grade 11 teachers' understanding and practice of practical work in teaching Physical Sciences within NCS. The intention of this chapter is to present the background to the study, rationale and significance, purpose, problem statement, research design of the study and an outline of the chapters.

1.2 BACKGROUND TO THE STUDY

The background to the study outlines the expectations of the transformation of the South African education system from the old curriculum, NATED 550 to the new curriculum, NCS. After 1994, the new democratically elected government of South Africa, revolutionised schooling by introducing an Outcomes-Based Education (OBE) focused curriculum. The old curriculum, NATED 550 was phased out because of its outdated instructional methodology, which was teacher-centred and made most frequent use of the lecture method. According to Pillay (2004, p. 1), NATED 550 was “inflexible, syllabus was rigid and non-negotiable, and it was incapable of equipping learners with the ability to cope with the real world”. NATED 550 had been created to divide the country along racial grounds and it focused mainly on content acquisition rather than on science process skills (Clark & Linder, 2006). Furthermore, Clark and Linder (ibid) suggest that the pedagogical style of NATED 550 also encourages rote learning and a transmission mode of teaching. At the same time teaching and learning in most science classrooms was done through ‘talk and chalk’ teaching, copying of notes and cookbook-type practical lessons. Moreover Physical Sciences was poorly taught involving little contact with practical work.

Learners did not have the opportunity to engage in effective practical work. Against this background the description of practical work by Hodson (1990) applied even in the South African context. Hodson (1990, p. 33) describes practical work as “ill-conceived, confused and unproductive. It provides little of real education value. For many children, what goes on in the laboratory contributes little to their learning of science or their learning about science.” On closer examination this means that the practical work conducted in NATED 550 was not effective and did not promote meaningful learning.

South African curriculum developers believed that OBE would be the best possible solution to overcoming the legacy of Apartheid in education. Curriculum 2005, which 2005 was the anticipated year for the completion of the cycle in the General Education and Training (GET) phase, embraces OBE principles. However, according to Clark and Linder (2006), there were widespread criticisms of Curriculum 2005 concerning epistemological, political, moral and implementation difficulties. These criticisms led to the revision of the Curriculum 2005. The GET phase (Grade 1 to Grade 9) had a Revised National Curriculum Statement (RNCS) in 2003. However, revision was finalised and NCS in full the first time was introduced in 2005. The NCS was implemented in 2006 in the Further Education and Training (FET) phase, (Grade 10-12). Grade 11 learners were exposed to the NCS for the first time in 2006 when they were doing Grade 10. This study was conducted when all the Grades, (Grade R to Grade 12) were experiencing NCS curriculum. It is significant to emphasize that NCS embraced the same principles of Curriculum 2005 as that of OBE. The central aim of OBE was to shift from teacher-centred to learner-centred approaches. This shift implies that the focus of teachers had to change from being the imparter of knowledge to that of assisting learners in achieving the outcomes clearly defined by the curriculum. The NCS curriculum required teachers to structure their teaching towards the achievement of outcomes called learning outcomes (LO's). This requirement needs to be evident in the teachers' teaching plans and classroom instructional practices.

The implementation of the NCS curriculum brought about changes which were most evident in the subject of Physical Sciences. Physical Sciences plays a very important role in the lives of

South African learners “due to its influence on scientific and technological development, which underpins our country’s economic growth and social well being of our community” (Department of Education, 2005, p. 9). The innovations introduced with NCS curriculum on teaching and learning of Physical Sciences placed priority on scientific literacy for all learners. According to the NCS policy document, Physical Sciences is “the subject that focuses on investigating physical and chemical phenomenon through scientific inquiry” (Department of Education, 2005, p. 6). Furthermore, the NCS Grade 10-12 (general) Physical Sciences policy document states that there are three LO’s to be achieved and LO1 is achieved when “ the learner is able to use process skills, critical thinking, scientific reasoning and strategies to investigate and solve problems in a variety of scientific, technological, environmental and everyday contexts” (Department of Education, 2005, p. 13).

Learning Outcome one has four assessment standards (AS). According to the NCS Physical Sciences policy document (2005, pp. 21-23) the four AS for Grade 11 are:

- AS 1: plan and conduct scientific investigation to collect data systematically with regard to accuracy, reliability and the need to control variables.
- AS 2: seek patterns and trends, represent them in different forms to draw conclusions, and formulate simple generalisations.
- AS 3: apply known problem-solving strategies to solve multi-step problems.
- AS 4: communicate information and present scientific arguments with clarity and precision.

The thrust for LO1 is “practical scientific inquiry and problem solving skills” (Department of Education, 2005, p. 13). Yoon and Kim (2010) explain that one of the important disciplines to orient learners towards skills in scientific inquiry and process is the vey notion of inquiry-based practical work. Scientific inquiry and problem solving skills may be developed by learners when they are given an opportunity to conduct practical work during science lessons. Hence it is the intention of the NCS curriculum that the subject Physical Sciences should be learnt through practical work.

1.3 RATIONALE FOR STUDY

The rationale indicates that this study is worth doing because the emphasis is on NCS curriculum which has impacted the teaching of Physical Sciences and led to great changes when compared to the old curriculum, NATED 550 in the expectations both of the ways in which teachers should teach as well as the way in which learners should learn. The study emanates from the challenging task that faces Physical Sciences Grade 11 teachers as they implement the NCS curriculum, developing science programmes that will achieve LO1. The emphasis on practical work with scientific inquiry by NCS challenges teachers to come up with new approaches that feature inquiry for teaching and learning. Kim and Tan (2011, p. 466) give evidence that “content knowledge alone is insufficient to build self-efficacy and affective teaching of practical work, teachers need to know how their thought processes and teaching are situated in the pedagogical contexts of students, curriculum and classroom”.

Practical work has gradually acquired an increasingly prominent place in Physical Sciences within the NCS curriculum. Despite the view that practical work is regarded as a pillar of effective teaching and learning in Physical Sciences, some studies revealed that practical work within NCS is not fully implemented (Pillay, 2004; Stoffel, 2005). There is some evidence that the implementation of OBE in science, particularly on practical work is slower than anticipated (Hatting, Rogan, Aldous, Howie & Venter, 2005; Hatting, Aldous, & Rogan, 2007; Kapenda, Kandjeo-Marega, Kasandra, & Lubben, 2002). Furthermore these studies indicated that in some cases the teaching of Physical Sciences is still content-based. The idea of teaching the subject using inquiry-based practical work is new to the majority of Physical Sciences teachers (Kim & Chin, 2011). According to Kim and Tan (2011), practical work is still regarded as one of the most challenging tasks for many science teachers and is practiced infrequently or inefficiently in many science classrooms. There are some studies that discuss the difficulties of teaching Physical Sciences using inquiry-based practical work (Abrahams & Millar, 2008; Abrahams & Saglam, 2009; Hatting et al., 2005, 2007; Kapenda et al., 2002).

While some of the above studies have explored effectiveness of practical work (Abrahams & Millar, 2008), characteristics of practical work (Kapenda et al., 2002) teachers view on practical

work (Abraham & Saglam, 2009) and teachers understanding of nature of practical work (Pekmez, Philip & Gott, 2005), none of the studies explored the teachers' understanding and how it permeated their actual classroom practice specifically after NCS implementation. To some extent, there has not been exploration on the understanding of how exactly teachers' understanding about the nature and purpose of practical work relates to the teachers' use of practical work as an instructional strategy. On these grounds, the focus of this study is on teachers' conception of practical work that is understanding, pedagogical methods and justification in the context of NCS for Physical Sciences. Hence, the focus is on how Grade 11 Physical Sciences teachers translate their understanding and knowledge of practical work into classroom practices.

Implementing the NCS curriculum successfully and to meet the demands of the curriculum require teachers with strong pedagogical content knowledge (PCK), (Shulman, 1986). Teachers' PCK can play a crucial role in the implementation of the NCS with new content and instructional methods. So PCK will enable the teacher to interpret the subject matter and to find different ways to represent it and make it accessible to learners (Shulman, 1986). However, none of the above studies in South Africa have explored PCK for teachers, specifically for teaching inquiry-based practical work. Furthermore, there is a need to enforce the role of practical work in Physical Sciences teaching and learning as per NCS curriculum expectations. The above statements justify the need for exploration of the teachers' understanding in relation to their practice of practical work. It is imperative to explore whether understanding of practical work forms the basis of implementation in the classroom. I postulate that some teachers are experiencing difficulties in using inquiry-based practical work to teach Physical Sciences, since their school education focused mainly on science content and their tertiary education focused on teaching methods.

1.4 PURPOSE OF THE STUDY

The purpose of the study is what underlies the motivation to conduct the study. This study explored Grade 11 Physical Sciences teachers' conception of practical work within the South

African new curriculum, NCS. The word conception does not only imply scientific explanation of practical work, but also the practice and explanation of actions or the grounds for doing practical work. Grade 11 Physical Sciences teachers are suitable participants for this study because they received three days training in workshops conducted in 2005. They were supposed to start implementing NCS curriculum in 2006 with Grade 10 learners.

Teachers are required to adopt new practices and innovation that came with NCS to translate their knowledge and understanding of practical work into classroom practice. My focus was on how teachers' knowledge and understanding of practical work came to shape the way in which they used it to teach Physical Sciences. Most of these teachers had been in the system long before the implementation of the NCS curriculum. In the old curriculum, NATED 550 these teachers were provided with a rigid syllabus and taught according to the syllabus (Pillay, 2004). The new curriculum, NCS requires teachers to shift their focus to learner-centred activities, designing programmes aimed to assist learners in achieving the learning outcomes. Hatting et al., (2007) indicate the commitment and positive attitude of teachers and learners towards practical work, however they also argue that there is no evidence of effective practice in the use of practical work in school science. Furthermore, Rogan and Grayson (2003, p. 1172) indicate that “.. policy documents themselves contain many visionary and educationally sound ideas; the implementation of these ideas is proving to be much slower and more difficult.” The challenge that is facing teachers is to make practical work a more effective teaching and learning strategy within the NCS curriculum than it was in NATED 550.

1.5 STATEMENT OF PROBLEM

The problem statement outlines direction and focus of this study. In the light of what has been presented on the background of the study, the research was centred on answering the question:

What are Grade 11 teachers' conceptions of practical work in Physical Sciences within the National Curriculum Statement (NCS) curriculum?

In exploring the main research question the study was guided by the following critical questions:

- What are the Grade 11 Physical Sciences teachers understanding of practical work in Physical Sciences?
- How do Grade 11 Physical Sciences teachers use practical work to teach Physical Sciences?
- Why do Grade 11 Physical Sciences teachers use practical work in the teaching of Physical Sciences in the way that they do?

1.6 RESEARCH DESIGN AND METHODOLOGY

The research design included in this chapter highlights the strategy that will be used for collecting data to explore the conception of practical work by Grade 11 teachers in Physical Sciences. The methodology, research parameters and research instruments that will be used and their justification are stated. A detailed research design and methodology is described in chapter three. Two Grade 11 Physical Sciences teachers from the Empangeni District participated actively in the study. Case study was used to allow for conception of practical work by teachers to be studied in a holistic manner within a real life situation. (Bassey, 1999). For this study, the understanding of how practical work is used to teach Physical Sciences could not be explored in numerical analysis, but case study method penetrated the situation (Cohen, Manion & Morrison, 2007) to provide an in-depth thick description through qualitative data collection (Leedy & Ormrod, 2005).

Qualitative data was obtained using semi-structured pre-observation and post-observation interviews and classroom observations in two high schools. Qualitative research helps to obtain insight into particular educational process and practices that exist within a specific location (Denzin & Lincoln, 2000). Pre-interviews helped in obtaining teachers' understanding and purpose about practical work. Classroom observations were used in order to generate information about teachers' actual practices. Post-interviews were informed by classroom observations. Qualitative data analysis enabled recommendations to be made for the

improvement of the use of inquiry-based practical work in the teaching and learning of Physical Sciences. The research design and methodology will be discussed in greater detail in chapter three.

1.7 SIGNIFICANCE OF THE STUDY

The significance of a study is an indication of both why that study is relevant and to whom it will be important. This study will be characterised by the transformations made by teachers when implementing NCS curriculum. The study will assist the Department of Education in providing information about the status of Physical Sciences practical work implementation in relation to the NCS curriculum intention in the Empangeni District. Hence, they can devise sound means for the factors that impede the proper implementation. In order to improve the quality of teaching and learning of Physical Sciences, the teachers, Subject Education Specialist (SES) and educational administrators have to gain a better understanding of what is happening in South African classrooms as far as practical work is concerned. The information from the study will be of benefit to Physical Sciences SES, to use during in-service intervention with teachers in their districts. Physical Sciences SES will be aware of the need to assist and provide supervision to teachers in gaining better insight on those concepts related to practical work. Moreover, curriculum developers will benefit from the findings on how practical work is used in the classroom.

The study provides base line information about Grade 11 Physical Sciences teachers' conception of practical work within NCS which will add to South African research with regard to how the conception of practical work shapes their classroom practise. The teachers will gain a better understanding of inquiry-based practical work and how it impacts upon the teaching and learning of Physical Sciences. It will also inform practising Physical Sciences teachers with regard to the types of practical work used in science teaching and how to use practical work as a teaching strategy in the teaching of Physical Sciences. The participants will also benefit from the study through recommendations that will be made in closure. Moreover, it may be used as a stepping

stone for those who may be interested in conducting further investigation on practical work within any new curriculum.

1.8 CHAPTER SUMMARY

In this chapter the study has been introduced with a brief discussion on the fundamental reasons why the research is being conducted. The rationale, the purpose of the study including the research questions, and the theoretical framework, are discussed. Then a brief outline of the research design is given.

1.9 PREVIEW OF FOLLOWING CHAPTERS

Chapter two explores some of the relevant literature in the field of practical work in science education. The definition and purpose of practical work will be examined from the point of view of various theorists. Analysis will also be made of the literature review of past studies conducted nationally and internationally with regard to practical work in Physical Sciences.

Chapter three describes the research design and methodology used in this study. The reasons for choosing case study methodology are described in detail. In this chapter, justification for the use of pre and post interviews, classroom observations, the sample, as well as the schools chosen for study will be outlined. The chapter will end with the limitations of the study.

Chapter four presents an analysis of data and present teachers' conception of practical work. The major findings from interviews and classroom observations will be analysed and interpreted in the light of practical work within NCS.

Finally, chapter five examines the critical questions in the light of findings and, discusses implications and recommendations of the study.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of the study was to explore Grade 11 Physical Sciences teachers' conception of practical work within the NCS curriculum. This exploration focused on Grade 11 Physical Sciences teachers' understanding and practices of practical work in teaching Physical Sciences within the NCS curriculum. It is for this reason that in this chapter I reviewed relevant literature on the meaning, significance and approaches to practical work. The aim of the literature review was to gain insight into the development and use of practical work by Physical Sciences' teachers. On the other hand, the overview of the theoretical framework highlights the importance of pedagogical content knowledge (PCK) of teachers for inquiry-based practical work.

2.2 PERSPECTIVES ON PRACTICAL WORK

The concept of practical work as it is used in science education may be cause for confusion, as one might ask how practical work differs from laboratory work or experimental work. 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 real objects and materials they are studying." Millar's definition implies that practical work can be conducted by the teacher or performed by learners. The manipulation of objects as suggested involves both "hands-on and minds-on" activities. On the other hand the author clarifies the preference of the term 'practical work' to 'laboratory work' or 'experimental work' since for laboratory work location is not the critical feature in characterising this kind of activity. According to Millar, the observation and manipulation of objects can also occur outside of school setting such as home or field. He further argues that experimental work (also experiment) is often used to mean the testing of prior hypothesis.

Woodley (2009, p. 9) gives a similar definition of practical work as Millar (2004), but one that is more inclusive as a “hands-on” learning experience, which prompts thinking about the world in which we live. This definition considers practical work as the activities that assist learners in making sense of the world through interaction with the world around them. Furthermore, Woodley classifies these learning experiences into two main categories, which are:

- core activities that support the development of practical skills and understanding of scientific concepts such as investigations, laboratory procedures and techniques,
- directly related activities which are closely related to core activities and provides valuable first-hand experience for learners such as designing and planning investigation, analysing results and teacher demonstration.

Using the same classification, Science Community Representing Education, SCORE (2009, p. 1) add a third category: “complementary activities which include surveys, simulations, presentation and science related visits”.

Lunetta, Hofstein and Clough (2007, p. 394) define laboratory activities as “learning experiences in which students interact with materials or with secondary data to observe and understand the natural world.” However, contrary to Millar’s (2004) definition, Lunetta et al. (2007) do not differentiate between the terms ‘practical work’ and ‘laboratory work’. Lunetta et al. (2007) in their definition put emphasis on making observations and manipulating materials when learners construct scientific knowledge, whether it may be inside or outside the laboratory. Furthermore, the definition of practical work by Lunetta et al. (2007, p. 394) gives examples of activities such as interacting with “aerial photographs to examine lunar and earth geographical features; spectra to examine the nature of stars and atmosphere; sonar images to examine living system.” Some of these activities can take place out of school or the laboratory setting. Writing in the nineties, Dreckmeyer (1994) suggests that the concept ‘laboratory’ should not be limited to a physical building, but it defines any place where a scientist can work to investigate natural phenomena. According to Dreckmeyer (1994, p. 84) “a laboratory exists wherever and whenever investigators are working.” Hodson (1990) adds the same evidence that practical work need not

always comprise activities at the laboratory bench, but is any learning method that requires being active rather than passive, according with the belief that students learn best by direct experience.

Stoffels (2005) clarifies practical work as those teaching and learning situations that offer learners ample opportunity to practice the processes of investigation. Stoffels (2005, p. 148) further explains that this would involve “hands-on or minds-on” practical learning opportunities where learners practice and develop various process skills. According to Stoffels (2005) the process skills referred to are amongst others questioning, observing, hypothesising, predicting and collecting, recording, analysis and interpretation of data. According to this definition, it appears that practical work is a way of teaching and learning that gives learners an opportunity to practice and develop process skills.

Pekmez, Johnson and Gott (2005) define practical work in terms of the perspective of the movements influencing it. First, they define the discovery approach, which perceives practical work as the means for discovery learning, where learners find things for themselves so as to develop their thinking. Second, they define the process approach, which perceives practical work as the methodology that will give opportunities to learners to practice what scientists do when they are acting as a scientist. Lastly they define the investigation approach, where practical work is seen as a more holistic approach of problem solving activities in which “learners have to be thinking about what lies behind what they are doing rather than simply applying a practiced process” (Pekmez et al., 2005, p. 9). From the ideas of these authors it is worth noting that there is a similarity between the process approach movement and the investigation movement in terms of a definition of practical work. Both movements are concerned with the how science is practiced, however the investigation movement moves a step further by being concerned with the thinking behind the practice of science. Hence, according to the investigation movement practical work is the approach to teaching and learning that will enable learners to develop process skills (procedural understanding) and also enhance their understanding of concepts, laws and theories of physical science (substantive understanding).

There is no specific consensus about what is meant by the term practical work. The above meanings infuse a variety of terms or explanations to describe practical work. However these meanings are based on a similar perspective regardless of the use of the term ‘practical’ or ‘laboratory’ work. Lunetta et al. (2007), Millar (2004) and Stoffels (2005) in their definition of practical work or laboratory work develop the meaning of the strategies or activities which can be conducted by a teacher or a teacher together with learners or learners on their own, either individually or in groups that gives learners an opportunity to practice and develop process skills. Woodley (2009) defines practical work in terms of types or categories and Pekmez et al. (2005) define practical work in terms of movements. Regardless of different meanings, most definitions include investigations along with, laboratory procedures and techniques. Nevertheless, the role of practical work is highly regarded in science teaching and the top priority is the quality practical work in all school (SCORE, 2009).

2.3 PRACTICAL WORK AND ITS PLACE WITHIN NCS CURRICULUM

According to the NCS Physical Sciences policy document, Physical Sciences focus on investigating physical and chemical phenomena through scientific inquiry (Department of Education, 2005). From the overview of the NCS Physical Sciences policy document emphasis is on learning science through inquiry. Learning through inquiry refers to the ways in which learners can investigate the natural world, explain and justify assertion based upon evidence while sensing the spirit of science (Hofstein & Lunetta, 2003). So practical work to learners will be ‘hands-on’ experiments where there are no certain known answers to questions and learners strive to find out the result (Kim & Chin, 2011). The Physical Sciences policy document lists the following activities that learners should engage in during practical work:

collect appropriate apparatus; assemble apparatus; use apparatus; identify and describe variable; write an investigative question or hypothesis; take measurements; make observations; record observations; analyse data using graphs; calculation, etc.; interpret results; formulate hypothesis; test hypothesis; synthesise; and evaluate and give conclusions (Department of Education, 2005, p. 10).

The above activities can be achieved through practical work with inquiry orientation (Kim & Chin, 2011). According to Hofstein and Lunetta (2003, p. 30) inquiry includes activities that are identical to those listed above that involve,

observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in the light of experimental evidence; using tools to gather, analyse and interpret data; proposing answers, explanations and predictions; and communicating results.

It can be observed that according to the NCS Physical Sciences policy document, inquiry-based practical work is fundamental in the teaching and learning of Physical Sciences.

Therefore, in this study the term practical work was used in preference to the term laboratory work. Hence the meaning of practical work that will be used in this study is the one that is given in the Physical Sciences policy documents and guidelines as explained above. However, teaching Physical Sciences using inquiry-based practical work is new to a majority of teachers in South African schools. A crucial part in the NCS curriculum is for teachers to infuse practical work with inquiry orientation in their teaching.

2.4 THE IMPORTANCE AND PURPOSE OF PRACTICAL WORK IN SCIENCE AND WITHIN NCS CURRICULUM

Practical work, both inside the classroom or outside the classroom, is an essential component of Physical Sciences teaching and learning (Bennett, 2003; Gomes, Borges, & Justi, 2008; Lunetta et al., 2007; Millar, 2004; Millar 2009). There are many stated reasons for inclusion of practical work in this subject. Millar (2004, pp. 18-19) identifies the value of practical work as:

giving students a 'feel' for their problematic of measurements, and appreciation of the ever-presence of uncertainty. It is also an important tool to teach about experimental design. Indeed research suggests that students design better investigations when they actually carry them out than when only asked to write a plan, feedback from experience improves design.

Hayward (2003) shares the same view as Millar on the importance of practical work in Physical Sciences. Moreover, Hayward (2003, p. 3) recommends that practical work be introduced early into learners' education so that learners will be "experienced at doing practicals and will have learned the disciplines required for working in the laboratory."

From Millar (2004) and Hayward's (2003) point of view the importance of practical work is based only on a learners' perspective. SCORE (2009) notes the importance of practical work in school science and stresses the point that even teachers gain confidence when conducting or engaging learners in practical work over a period of time. Similarly, Gomes et al. (2008) mentions that most science teachers endorse the view that practical work has the potential of making a difference in terms of learners' interest and view of science. Adding evidence to this, Cheung (2007) highlights that teachers have pedagogical problems with teaching inquiry-based practical work, but this can be alleviated by teachers doing inquiry-based practical work more often in their classrooms so that they will gain confidence. That is why Yoon and Kim (2010) assert the importance of thorough examination of the nature and purpose of practical work taking place within science teaching in order to assist teachers with confidence of conducting inquiry-based practical work.

On the other hand Millar (2004, p. 2) argues that:

it is also important to distinguish, and keep in mind, that the school science curriculum in most countries has two distinct purposes. First, it aims to provide every young person with sufficient understanding of science to participate confidently and effectively in the modern world – a 'scientific literacy' aim. Second, advanced societies require a steady supply of new recruits to jobs requiring more detailed scientific knowledge and expertise; school science provides the foundations for more advanced study leading to such jobs.

The importance of practical work in school science is widely accepted, but it is important that curriculum developers and the Department of Education ensure that practical work genuinely supports learning and teaching to achieve its purpose. SCORE (2009) agrees that effective pedagogy is at the heart of improving the quality of practical work.

SCORE (2009, p. 5) mentions that over the years there have been several studies that have reported teachers' views about the purpose or aims of practical work and some of the most frequently stated aims for practical work by teachers are:

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

The aims stated above mainly focus on scientific skills. At a more complex level, Millar (2004) groups the aims of practical work into four major categories, the development of: conceptual understanding; learners interest and motivation; science process skills and understanding of nature of science and scientific inquiry. The categorisation of the practical work divided into four major groups by Millar (2004) was adopted for this study particularly because one of the aims specified by Millar emphasises developing learners' understanding of the ideas about the nature of science and scientific inquiry, which is highly advocated in Physical Sciences within NCS curriculum.

Even though there are various purposes of practical work, the NCS Physical Sciences policy document anticipates that practical work will contribute to the development of skills and processes that will allow learners to “solve problems, think critically, make decisions, find answers and satisfy their curiosity” (Department of Education, 2005, p.10). The NCS curriculum emphasises the purpose of using practical work to learn the process of problem solving, rather than confirming facts and theories. According to the NCS Physical Sciences policy document, LO-1 seeks to develop learners' scientific inquiry and problem solving skills through effective inquiry-based science teaching and learning (Department of Education, 2005, p. 10). Scientific inquiry has been stressed in the NCS curriculum as a set of pedagogical methods that models scientific practices and encourages students to gain content knowledge through problem solving. According to the NCS Physical Sciences policy document, scientific inquiry “enables learners to act confidently in exploring their curiosity about natural phenomena, and in investigating relationships and solving problems in scientific, technological and environmental contexts” (Department of Education, 2005, p. 23).

Supporting the above statement from the Physical sciences policy document, Yoon and Kim (2010) point out that practical work is one of the most important strategies that can be used to orient students towards scientific inquiry and developing process skills. Adding evidence to this, Kim and Chin (2011) suggest other forms of practical work that can be used to orientate learners towards inquiry-based learning namely, investigations, practical exercises or fieldwork. In NCS Physical Sciences, practical work needs to be conducted for the development of scientific knowledge and scientific processes.

2.5 TYPES OF PRACTICAL WORK

These are the practical activities conducted during the teaching and learning of Physical Sciences. Millar and Abrahams (2009, p. 61) classify these practical activities according to their learning objectives as seen in Table 2.1 below. Each classification for a specific type of practical activity has its own objective as outlined in the table below.

Table 2.1 Classification of activities by their main learning objectives.

	Type	Main Objective
A	Scientific Knowledge	To help student develop their knowledge of the natural world and their understanding of some main ideas, theories and model that science uses to explain.
B	Practical skills	To help student learn how to use some pieces of scientific apparatus and to follow some standard scientific procedures
C	Inquiry process	To develop student understanding of the scientific approach to inquiry (e.g. how to design an investigation, assess and evaluate data, process data to draw conclusions, evaluate the confidence with which these can be asserted).

Moreover, Berg (2009, p. 4) uses the same classifications, dividing practical work by respective purpose.

- concept practical work with emphasis on teaching concepts and overcoming misconceptions,
- inquiry practical work with emphasis on learning how to do research: exercising intellectual skills needed in generating and validating knowledge,
- instrument practical work with emphasis on learning a manipulative skills such as using microscopes, making solutions, measuring with oscilloscopes.

Each of these types of practical work requires a different teaching, learning and assessment approach. Physical Sciences teachers with adequate PCK will be able to make a distinction between concept, inquiry and instrument practical work.

According to Pekmez (2005, p. 13) practical work can be classified under:

- skill-use to help learners to gain abilities or acquire a particular skill like how to use equipments;
- demonstration-used by teachers to verify facts or for dangerous experiments.
- illustration-use to prove or verify a particular concept, law or principle,
- Investigation-used to provide learners with opportunity to use concepts, cognitive processes and skills to solve problems.

It is significant to note that Pekmez (2005) indicates that amongst all these types the most used type of practical work in schools is demonstration while investigations were rarely or never done. The findings of the study by Pekmez (2005) on science teachers' understanding of practical work, reveals that teachers have no adequate knowledge of the different types and role of practical work, especially in terms of procedural knowledge. Pekmez (ibid) argue that investigations play a pivotal role in what is characterised as inquiry approach to science

education. Pekmez's study reveals that teachers are reluctant to conduct inquiry-based practical work.

Rogan and Grayson (2003) classify the types of practical work according to levels. Rogan and Grayson (2003) developed a framework to explore Curriculum 2005 implementation in order to understand, analyse and express the extent to which the ideas of a given curriculum are being implemented. Table 2.2 below is the profile of implementation for science practical work in which practical activities are classified according to levels. Level 1 and 2 are low levels, where most of the practical work is conducted by the teachers. Level 3 and 4 are activities that put emphasis on learner-centred approaches.

Table 2.2: Profile of implementation for science practical work.

Level	Type of science practical work
1	<ul style="list-style-type: none"> • Teachers use classroom demonstrations to help develop concepts. • Teacher uses specimens found in local environment to illustrate lessons.
2	<ul style="list-style-type: none"> • Teacher uses demonstrations to promote some form of learner inquiry. • Some learners assist in planning and performing the demonstration. Learners participate in closed (cook-book) practical work. • Learners communicate data using graphs and tables.
3	<ul style="list-style-type: none"> • Teachers design practical work in such a way as to encourage learner discovery of information. • Learners perform guided discovery type practical work in small groups engaging in hands on activities. • Learners can write a scientific report in which they can justify their conclusions based on the data collected.
4	<ul style="list-style-type: none"> • Learners design and do their open-ended investigations. • Learners reflect on the quality of the design and data collected and

	<p style="text-align: center;">make improvements when and where necessary</p> <ul style="list-style-type: none"> • Learners can interpret data in support of competing theories or explanations.
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The levels of practical work in the profile of implementation (Rogan & Grayson, 2003) was relevant for this study as the teachers were being investigated on how they conduct practical work to teach Physical Sciences within the NCS curriculum.

The NCS curriculum (Physical Sciences) places emphasis on investigation and experiments as the most significant trend in practical work. According to the NCS Physical Sciences policy document, “practical investigations and experiments should assess all learning outcomes with the focus on the practical work aspects and the process skills required for scientific inquiry and problem solving” (Department of Education, 2008, p.10). The research report (SCORE, 2009) also mentions that investigations and fieldwork are regarded as the core activities of practical work. Although scientific investigation can be perceived from different perspectives, Hackling (2005) defines scientific investigation as a scientific problem which requires the learners to plan a course of action, carry out an activity and collect the necessary data, organise, interpret and reach conclusion which is interpreted in some form. According to Hackling (2005, p. 3) the scientific investigation process is:

- Planning
 - Problem identification and analysis
 - Identification of variables
 - Formulation of research question or hypothesis and predictions
 - Operationalise variables, plan the design and procedure
- Conducting
 - Conduct preliminary trials
 - Carry out the experiment, observe, measure and record data
- Processing
 - Use science knowledge to develop explanations for patterns, trends or relationships in data

- Analyse data, identify patterns or trends in data and relationships between variables
- Organise data, calculate, construct graphs
- Evaluating
 - Evaluate the design of the experiment and the techniques or methods used
 - Evaluate findings in relation to the problem, question or hypothesis.

The above definitions and comprehensive model highlight the initiative of learners to find answers to a problem, however they need to do that focusing on scientific ways of working rather than using the results of practical work to support teaching of science content (Millar, 2009). Millar adds that encouraging learners to pursue their own inquiries taps into their natural curiosity and finding things out for themselves, through their own efforts, seems naturally and developmentally, rather than coercive, and may also help them to remember those things better. Gomes et al. (2008) agree with Hackling (2005) and add that the processes and skills related to investigative activities may be seen as the result of the interaction between conceptual and procedural knowledge. The degree of openness of investigation may vary depending on the objective of the activity. For example, for verification that is lowest level of inquiry, the problem to be investigated, apparatus to be used, the procedure and answers are all given to learners whereas at the highest level, which is open inquiry, learners are required to determine all these for themselves (Millar, 2009).

Although the NCS Physical Sciences policy document gives prominence to investigations, there are other types of practical work that can be used in school science. Practical work should therefore be considered as a vehicle through which learners' scientific inquiry can be enhanced. Therefore the emphasis of scientific inquiry by the NCS curriculum challenges teachers to come up with new approaches that feature inquiry in their teaching. Hence, it will be interesting in this study to gather an understanding of teacher views on the types and purpose of practical work and also the link between the type of practical work the teacher conducts and the purpose that this serve. Bennett (2003) indicates the importance of a link between the type of practical work the teacher used and its purpose. The question is to find out if teachers are effectively implementing the NCS curriculum. The answers can be found in both international and local past studies.

2.6 RESEARCH ON TEACHERS PERCEPTIONS OF PRACTICAL WORK

In order to understand the focus of practical work in teaching and learning science, it is important to discuss the recent studies. The discussion on practical work will start with South African studies and then followed by international studies.

A study by Hatting, Aldous and Rogan (2007) investigated some factors influencing the quality of practical work in science classrooms in South African schools. The focus was on the implementation of practical work within the new science curriculum, from a sample of 117 secondary science teachers in Mpumalanga. The study revealed that practical work is conducted in most science classes even though little is known about factors that can facilitate its implementation. This indicated the commitment and positive attitude of teachers and learners towards practical work. However there is no evidence of effective practice in the use of practical work in school science. According to Hatting et al. (2007), the most frequently used practice is level 1. According to Rogan and Grayson (2003), this is the framework in which learners mainly observe the teacher who executes the demonstration. The challenge that is facing teachers is to make practical work a more effective teaching and learning strategy than it is at present. One of the findings was that the utilisation of practical work is not determined by physical resources. For example, they cited the case of a school with 4 laboratories that did not undertake any practical work. In cases where teachers were motivated, they will find ways to do practical work even in the most poorly resourced schools.

Dlamini (2008) conducted a study exploring the teaching of scientific investigation by Life and Natural Sciences educators in Bushbuckridge. This study was conducted a year after the introduction of NCS. The findings highlighted that most teachers use a teacher-centred teaching methodology, rather than open inquiry in teaching scientific investigations. Dlamini identifies the gap between teaching practice and Departmental expectations. More than 50% of teachers received training through inquiry for five days during curriculum implementation. Dlamini identified the following factors as hampering the teaching of scientific inquiry listed from the one with high percentage to the one with low percentage:

- insufficient in-service teacher workshop,
- time allocated to science,
- use of second language for teaching science,
- pressure to cover content,
- poor learners' science background,
- teacher workload.

The implication and recommendation is that teachers lack basic knowledge of instruction and are insufficiently skilled in strategies to implement a new curriculum in teaching science.

Pillay (2004) conducted a case study on an exploration of Biology teachers' practice with regard to practical work and how it relates to the NCS-FET Life Sciences policy document. Pillay (2004) used questionnaires and focused on group interviews to get a deeper insight and understanding of teacher practices within South African context. According to Pillay (2004), the conceptual framework within this study was located is sociotransformative constructivism. The highlight of the findings revealed that teachers resort to demonstrations and not to hands-on activity for learners due to the time factor. The role of the teacher remained confined to being the purveyor of knowledge. So teachers did not conceive practical work to include inquiry based learning, problem solving, or critical and creative thinking. Pillay continued to investigate the contextual factors that influence teachers' practice. According to Pillay teachers were facing challenges of a lack of resources, a lack of laboratory assistance and a limited method of assessment in order to embrace the philosophy of NCS-FET Life Sciences policy.

Stoffel (2005) conducted a case study on a single science teacher on the use of learning support material (LSM) for practical work. The teacher had 10 years teaching experience from Grade 9 to Grade 12. The teacher holds a 4-year composite science education degree. Even though one may not generalize from a single case study, the findings can nonetheless be useful. The teacher performed demonstrations and then learners completed the worksheet taken from SciGuide as LSM. The reason stated by the teacher for demonstration is the focus on observational skills for

learners. However the lesson plan did not show observational skills as the objective of practical work. According to Stoffel, the teacher approach was teacher-centred and in a typical way a 'cook-book approach' to practical work was used. The implication of this study is that the teacher fails to adhere to the requirements of the curriculum. Stoffel suggested that what is needed is a comprehensive and far-reaching teacher development initiative, geared at boosting a teachers' confidence and competence in fully exploring the curriculum's potential.

Kim and Chin (2011) explored pre-service teachers' views on practical work with inquiry orientation in the science classroom. Using questionnaires, discussions and writing, data was collected from 25 third year students doing elementary science method course in Korea. Despite that inquiry based teaching was introduced and encouraged, the findings revealed that pre-service teachers hold a narrow understanding towards inquiry and practical work. According to the study inquiry processes do not seem possible to be done in everyday science classroom. Pre-service teachers viewed practical work as a tool to teach scientific knowledge, due to the emphasis on content knowledge in science teaching. So practical work with inquiry was such a challenging task and teachers were reluctant to practice it in their teaching. Lack of teachers' knowledge, skills and experience, lack of time, poor laboratory facilities and overloaded content in curricula were all difficulties teachers faced in practice inquiry-based teaching. However, Kim and Chin (2011) added that the examination system does not encourage this form of teaching which adds to the challenge of introducing it in classes. Therefore Kim and Chin (2011) suggested the need for thorough examination on teachers' situated context for development of inquiry-based practical work.

Pekmez et al. (2005) conducted a study on teachers understanding of the nature and purpose of practical work. The data was collected from 24 science teachers in England. The sample included both males and females and most of the teachers had more than 10 years teaching experience. Structured individual interviews and classroom observations were used to collect data. According to Pekmez et al., all of the teachers regarded practical work as beneficial, but for different reasons. Reasons were categorised as substantive idea, procedural ideas, motivation and

communication. All teachers knew about the common types of practical work, like demonstrations, illustrations and investigations. For teachers, understanding means mainly a substantive sense as in learning theory better, so they do not realised different outcomes of different kinds of practical work. Pekmez et al. suggested that for improvement in this area first priority should be given to curriculum and teacher training programmes.

Abrahams and Saglam (2009) conducted a survey of teachers' views on practical work in secondary schools in England and Wales. They found that despite many changes, with the introduction of the new curriculum teachers' view about the aims of practical work for pupils in Key Stage 3 (learners between ages 11-14) remained unchanged. In Key Stage 4 (learners between the ages 15-16) however, there was a most substantial change in teachers' aims for practical work. The difference is that in Key Stage 3 learners do not undertake public examinations involving practical work, where at Key Stage 4 practical investigations are assessed. Abrahams and Saglam (2009) argued that the National Curriculum did not generate any pressure on teachers at Key Stage 3 to change their pedagogy regarding practical work.

Practical work is not a distinctive aspect of secondary education in Brazilian schools due scarce resources and previous models of science teacher education (Gomes et al., 2008). Gomes et al. conducted a study to investigate the relationship between the students' understanding of the aims of an investigative activity and their performance when conducting it. According to the authors, the use of investigative activities in science education as a teaching and learning strategy depended mainly on learners' competence and skills when planning and implementing the task to obtain conclusions. So the aim of the study was to investigate whether there is any relationship between the recognition of the aims of investigative activities that are proposed and the learner competence to perform. The results obtained showed that most students had some difficulty recalling the declared aims of the activities but those that succeeded in recognizing the stated aims of the tasks showed a superior performance in conducting their investigations.

In these studies there is an indication that teachers adapt their practices slowly when faced with new curricula. The NCS curriculum specifies that practical work should be learner-centred, carried out by learners but the studies conducted in South Africa after NCS implementation show the gap between the curriculum expectations and what teachers do or what learners experience in class (Dlamini, 2008; Hatting et al., 2007; Pillay, 2004; Stoffel, 2005). However, even with the studies conducted, the international findings cited here reveal that teachers are reluctant to conduct inquiry-based practical work. The South African findings further match the findings made internationally.

A review of literature shows very few studies conducted on teaching using practical work within South African new curriculum, NCS. Most of the research relevant to this study, which has been done on practical work, has been on teachers' understandings of practical work, and on factors influencing the quality of practical work, rather than on the link between the teachers' understanding of practical work and their instructional practices. Hence, not so many studies have been done recently, with the introduction of NCS in South Africa on teachers understanding of practical work and how this influence their teaching so as to achieve the curriculum outcomes. The work of implementing and achieving curriculum outcomes is left on the shoulders of teachers. It is with this in mind that this study explores the link between South African teachers' understanding of practical work and their instructional practice.

2.7 THEORETICAL FRAMEWORK

The theoretical framework of the study is grounded by the Shulman's (1986) formulation of pedagogical content knowledge (PCK). Shulman (1986) defines pedagogical content knowledge as interwoven pedagogy and subject matter knowledge necessary for good disciplinary teaching. This theory in science education represents accumulation of common elements such as knowledge of subject matter, curricular, general pedagogy, and learners' possible misconception. Elaborating on Shulman's definition, Driel, Verloop and de Vos (1998, p. 674) add:

Pedagogical content knowledge is considered to be integrated knowledge which represents the teachers' accumulated wisdom with respect to their teaching practice. As craft knowledge guides the teachers' actions in practice, it

encompasses teachers' knowledge and beliefs with respect to various aspects such as pedagogy, students, subject matter, and the curriculum.

PCK is about that blending of content and pedagogy into an understanding of how particular topics, problems or issues are organised, represented and adapted to the diverse interests and abilities of learners, and presented for instruction (Shulman, 1986). This study will use the PCK for laboratory teaching which forms the knowledge base for teaching using inquiry-based practical work (Berg, 2009). The development of PCK involves a dramatic shift in teachers' understanding:

from being able to comprehend subject matter for themselves, to becoming able to elucidate subject matter in new ways, reorganise and partition it, clothe it in activities and emotions, in metaphors and exercises, and in examples and demonstrations, so that it can grasped by students (Shulman, 1987, p. 13).

This study will use the framework to look at two components of PCK which is the knowledge of teachers' instructional strategies and knowledge of the NCS curriculum requirements.

This theory was essential for this study because to switch from NATED 550 - which was a teacher-centred curriculum to the NCS - which is an outcomes-based curriculum placed implementation demands on teachers (Hatting et al., 2005). The teacher is central in the implementation of the curriculum and what goes on in the classroom. The focus on this study is on teachers' understanding and instructional practice of practical work within NCS curriculum. The concept of PCK in this study was used to understand how the two Grade 11 teachers' conceptualise and organise their teaching of Physical Sciences using practical work within NCS curriculum. Even though the productive practical work using investigative activities as a tool of teaching and learning depends mostly on learners' competence for developing a reasoned plan to conduct their investigation (Gomes et al., 2005), teachers need to provide learners with strategies and opportunities to practice. Teachers need to play a fundamental role in the implementation of the NCS curriculum. Using the theoretical framework of PCK the study explored the kind of knowledge and practices used by Grade 11 Physical sciences teachers as they teach using practical work.

The NCS Physical Sciences policy document encourages teachers to understand the nature of practical work and develop strategic ways of conducting practical work in their classroom teaching (Department of Education, 2005). Physical Sciences teachers are supposed to teach the NCS curriculum as set out in the NSC Physical Sciences policy document. Hence this PCK was applied to the phenomenon of teachers using practical work into their subject matter and pedagogy. Within the concept of understanding, the study looked not only for scientific explanation of practical work but also at an explanation of the grounds for conducting a particular type of practical work. This understanding calls for knowledge of subject matter, curricula and pedagogy. Over the past few years, in the old curriculum, the knowledge bases of teacher education have centred upon content knowledge, but recently in the NCS the focus includes pedagogy. Teachers with proper PCK are able to interpret the subject matter and finds different ways to represent it and make it accessible to learners (Shulman, 1987). Furthermore, Shulman (1987) recognised PCK as having the greatest impact on teachers' classroom practice.

Kim and Tan (2011, p.466) claim that “content knowledge alone is insufficient to build self-efficacy and effective teaching of practical work, teachers need to know how their thought processes and teaching are situated in the pedagogy context of students, curriculum and classroom”. For example in Millar's (2009) opinion, improving the quality of practical activities requires first that teachers become more aware that making links between the domain of objects and observables and the domain of ideas is demanding. Also, helping learners to design practical tasks which present this demand more explicitly requires that teachers analyse more carefully the objectives of the practical tasks they undertake, and become more aware of the cognitive challenge for their learners. To meet this demand, teachers' subject matter knowledge (SMK) alone will not help, but teachers also need to have PCK. Furthermore, Driel et al. (1998) and Bucat (2004) are in agreement when stating that there is a difference between SMK and PCK, knowing about a topic, and knowing about the teaching and learning demands of that particular topic. Adding evidence to this Mji and Makgato (2006), who from the findings of their study, identify teaching strategies and laboratory usage as direct influences on learners' poor performance in Physical Sciences. So these authors identify teachers' PCK as an important

aspect towards improving teaching strategies and laboratory usage in Physical Sciences within South African schools.

In looking for evidence of PCK on teachers' understanding and instructional practice on practical work, this study used suggestions regarding effective PCK for laboratory teaching formulated by Berg (2009) from the research on PCK for laboratory teaching. The following points were taken into consideration during interviews and classroom observation to explore the conception of practical work (Berg 2009, pp. 12-13).

- Decide about the main objective of practical work session
- If the emphasis is on concepts or investigation, look for prerequisite skills which need to be practiced
- Choose the main investigation skills and focus on them and make sure the skills are practiced during course of practical work
- Some skills can be practiced without laboratories, like graphing or graph interpretation
- Choose experiments which are meaningful to learners
- Formulate some questions:
 - To start the practical work (without giving away results)
 - For guidance during practical work activity
 - For post practical work discussion
- Give some questions for homework
- Look for appropriate ways to evaluate student performance depending on the type of practical work, for example, for concept practical work it will pen and paper test.

Moreover, the instructional practice for two Grade 11 teachers on how they conduct practical work was analysed using the modified Millar (2009) framework of the Practical Activity Analysis Inventory (PAAI). According to Millar (2009. p. 6), 'the way a practical activity is designed and presented may have significant influence on the extent to which its learning

objectives are attained'. According to the framework (Millar, 2009) the starting point about thinking about the effectiveness of practical work is to identify the learning objectives of the activity. Therefore the teachers' objectives of the practical activity are influenced about the teachers' view of what practical work is and its purpose.

2.8 CHAPTER SUMMARY

This chapter has provided an overview of the literature research pertinent to the study. The chapter begins with explicating the operational meanings, the purpose and varieties of practical work. NCS policy perspectives on practical work are discussed as the study explores its implementation. PCK formed the major theoretical framework for this study. PCK is a type of knowledge that teachers develop about how to teach particular content in a particular way in order to enhance learners understanding (Shulman, 1986). PCK is based on views that successfully implementing a curriculum is not easy and teaching scientific inquiry is complex. Teachers' PCK will be extended to look at the many effective ways of teaching of using practical work to teach any particular science content. Millar's (2009) frame work will be used to identify the level at which teachers used to engage learners in practical work.

The chapter to follow outlines the research design and methodology that focuses on data collection, instruments used, limitation of the study and ethical considerations.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter presents a descriptive account and justification for the research design and methodology used in this research. The qualitative approach and case study method was used in this research to explore the conception of practical work that two Grade 11 Physical Sciences teachers teaching within the NCS curriculum have. The chapter further describes and justifies the appropriateness of the data collection methods and instruments for the study. The chapter also addresses the data collection process and data analysis method used. The chapter ends with the issues of sampling technique, trustworthiness of the study, management of ethical issues involved and the limitation of the research.

3.2 RESEARCH DESIGN

Research design refers to a plan, strategy and a structure of conducting a research study and it provides the overall framework for collecting data (Leedy & Ormrod, 2005). In other words, research design spells out the procedure to be undertaken including when, how, from whom and under what conditions the data will be obtained. The rationale for the choice of research design is to have research that will provide results that can be judged trustworthy and reasonable (McMillan & Schumacher, 2006). The two types of research approaches used in most educational research are quantitative and qualitative. According to McMillan and Schumacher (2006, p. 66), “qualitative research explores the traits of individuals and settings in narrative or descriptive ways, whereas quantitative research is based on the measurement and the analysis of causal relationships between variables.” Qualitative and quantitative approaches differ in terms of the data collection instruments, type of data produced and types of question posed (Cohen, Manion & Morrison, 2007). Furthermore, qualitative research is the type of research that

emphasises gathering data in the form of words rather than numbers in order to explore a deeper understanding of the phenomena (McMillan & Schumacher, 2006). The decision to choose a specific research design should be based on its suitability to answer the research questions. Therefore, in this study I used a qualitative research approach in order to capture Grade 11 Physical Science teachers' understanding of practical work and to ascertain how they used practical work in the teaching of Physical Sciences within the NCS curriculum. For this study, the understanding of how practical work is conducted in Physical Sciences cannot be simply explored in numerical analysis, but by an in depth thick description through qualitative data.

The strength of a qualitative approach is that it can provide understanding and description of people's personal experience and exploration of the phenomenon's context (Creswell, 2007). Furthermore, according to McMillan and Schumacher (2006), qualitative approach is concerned with understanding social phenomena from the participants' perspective. Participants were free to express their thoughts, ideas and experiences in their natural settings without any form of interference. Regarding this study, the text data collected from the participants, two Grade 11 Physical Sciences teachers was used to reveal their understanding and the reasons for their practice of practical work. As a researcher I went to two different high schools to interview and observe the participants. Qualitative approach allowed for a detailed exploration on the understanding and practice of practical work by Grade 11 Physical Sciences' teachers to be undertaken.

In qualitative research, understanding is acquired by analysing the context within which the participants operate and narrating the meanings participants attach to this understanding. This suggests that qualitative approach can be used to explore or investigate the why and how reasons on the various aspects (Cohen et al., 2007). As a result, the data usually collected is in the form of written texts. Hence the data in qualitative research during analysis is categorised into patterns for data organising and reporting results (Leedy & Ormrod, 2005). In this study, the data collected from Grade 11 Physical Sciences teachers served to reveal their understanding about practical work, how they use practical work in their teaching of Physical Sciences and why they

use the types of practical work in teaching. The qualitative approach enabled the research questions to be answered by providing a rich picture on the actual understanding, practices of practical work and the reasons behind that understanding and practice.

Qualitative research is about gaining deeper insight into the nature of phenomena and it adopts the epistemological position of interpretivism. According to Guba and Lincoln (2005), the interpretivist paradigm is guided by a set of beliefs and feelings about the world and how it should be understood and studied. The interpretivist framework and interpretivist-based research focuses on meanings and attempts to understand the context and totality of each situation by employing a variety of qualitative methodology. The key feature in the interpretivist tradition pays particular attention to the social construction of knowledge through the search for patterns of meanings (Leedy & Ormrod, 2005). The interpretivist framework attempts to understand and interpret social situations by listening to the participants and by sharing their perceptions and experiences. In the case of this study, adopting an interpretivist paradigm, the researcher entered the social world of two schools using two teachers to engage with them and collect in-depth information regarding their understanding of practical work and how they use practical work in teaching Grade 11 learners. From the data collected, significant interpretations were made which fit the motivation, justification and significance of the study. The interpretivist paradigm was considered appropriate because it facilitated the exploration of meanings, understandings, motivations, experiences and practices of practical work by Grade 11 Physical Sciences teachers.

The interpretivist paradigm is underpinned by an ontology that confirms reality as something that can be understood by studying what people think about, their ideas and the meanings that are important to them (Amgen, 2006). Ontology, according to Cohen et al. (2007) deals with the question of what is real, and how one looks at reality. Regarding this study, the reality is known through the interaction of the researcher with participants by using pre and post interviews and classroom observations. These methods that were used allowed me to capture each teacher's conception of practical work. The epistemology of interpretivism that cites the relative nature of knowledge understands that knowledge is created, interpreted and understood from a social as

well as an individual perspective. As such, this paradigm seeks to explain the participant's behaviour from their individual viewpoint, as opposed to viewing them as passive actors whose action are completely determined by the situation in which they are located (Denzin & Lincoln, 2000). In order to gain a better understanding of individual behaviour, interpretivist researchers attempt to observe ongoing processes and researchers within this tradition generally select a small sample to provide an in-depth description and insight of the participants' social reality (Cohen et al., 2007). In this study I used strategies that bring the teachers into close view as they use practical work as a teaching strategy, such as interviews and classroom observation (McMillan & Schumacher, 2006).

Most qualitative researchers tend to start their work by asking general questions, then collecting large amounts of data and usually presenting their findings in words (Saunders, Lewis, & Thornhill, 2003). This research approach is classified as an inductive approach. It is important to have a clear theoretical position prior to data collection of either to use deductive or inductive approach. According to Saunders et al. (2003), a deductive approach arrives at conclusion by moving from theory to data. At the same time, the inductive research approach describes a study in which theory is developed from the observation of empirical reality, thus general inferences are induced from particular instances. The inductive approach- also known as building a theory, is the one in which the researcher starts with collecting data in an attempt to develop a theory. Knowledge has to begin with collecting facts and then trying to find some order in them. The current study is shaped using inductive research design. Saunders et al. (2003) noted that the inductive approach gives the chance to have more explanation of what is going on and less concern with the need to generalise. I started the research process by exploring and collecting the data from two different two Grade 11 teachers, using two different data collection instruments in order to explore the understanding and use of practical work within the NCS curriculum. The focus was to gain understanding for inclusion of practical work in Physical Sciences teaching and not to generalise the conclusions.

3.3 METHODOLOGY

This study therefore used a qualitative approach and a case study method. Opie (2004, p. 74) defines a case study as “an in depth study of interactions of a single instance in an enclosed system.” Opie goes on to indicate that the focus of the case study is on real situation with real people. Cohen et al. (2007, p. 253) share this view, stating that case study is “a research methodology that provides a closer look at reality and as a result provides detailed explanations of the phenomenon being investigated by focusing on specific instances in a bounded system.” Kimmel (2006) further reiterates this view by stating that a case study is a study of an instance in action, which provides a unique example of real people in real situations. In order to explore Grade 11 Physical Sciences teachers’ understanding and how they conduct practical work, case study method therefore seemed appropriate. Moreover, I could not explore the whole of Grade 11 Physical Sciences teachers, so I explored how two teachers conducted practical work in real life situations. Using a case study was more appropriate, as it is good for exploring issues in depth.

This study can be categorised as an educational case study as it explores an educational issue with Grade 11 Physical Sciences teachers. Moreover, Bassey (1999) when defining educational case study, sets out descriptors that characterises the study conducted. According to Bassey (1999, p. 62), educational case study is:

empirical enquiry which is conducted within a localised boundary of space and time (i.e. singularity), into interesting aspects of an educational activity, mainly in its natural context and within an ethic of respect for persons, in order to inform the judgements and decisions of practitioners or policy-makers...

The aim of this study was to draw attention and make recommendations as to what is happening inside the science classrooms as Grade 11 Physical Sciences teachers use practical work in their teaching. However, Yin (1994) and Thomas (2003) argue that the findings of a case study are not generalisable. Nevertheless, the case study method was chosen since generalisability was not the key purpose. As Yin (1994) indicates, case study offers the opportunity to explain why results happened rather than just find out what the results are, and as a researcher I took on the

responsibility of ensuring that the case provided answers to the research questions. The findings and recommendations made in this study might have a bearing on teachers' understanding of practical work and their practice of it.

According to Nisbet and Watt (2008), one of the characteristics of a case study is that it concentrates on a particular incident and attempts to locate the story of a certain aspect of behaviour in a particular setting and the factors influencing the situation. In this study, employing a case study methodology included looking in depth at how Grade 11 Physical Sciences teachers are implementing the NCS curriculum with regard to LO-1. Using a case study allowed the researcher to get rich data because the methods used within a case study allowed the researcher to get close to the teachers, thus giving opportunities to access subjective factors such as the thoughts, feelings and desires of teachers.

The advantage of a case study is that it provides "an audit trail by which other researchers may validate or challenge the findings, or construct alternative arguments' (Bassey, 1999, p. 57). The case study is more appropriate as the data from the research questions can provide an insight into other similar situations. The findings on the case could evoke further research and debates and also recommendations about the inclusion of practical work in science classrooms within NCS. Bassey (1999) further adds that another advantage of a case study is its uniqueness, as well as its capacity for understanding complexity in particular contexts. This case study provided the understanding of how teachers conduct practical work within the context of the NCS.

A multiple case design was adopted as the study was conducted in two different high schools with two different teachers (Yin, 1994; Stake, 2005). Multiple case designs have distinct advantages over single case design, because it takes into consideration the diversity of schools. Multiple case design allows for an investigation of what is particular to individual persons, to individual classrooms or individual schools. Differing views are permitted as they lead to multiple realities that become visible in each of the case studies. To some extent a multiple case

design reduces the disadvantage of a case study methodology such that results may not be generalisable, as multiple case findings are more reliable and convincing than a single case design. This study took interest in the activities of the case and not on generalising the results across schools in the Empangeni District.

The case study method has been used successfully in other studies on teachers' perception about practical work (Pillay, 2004; Stoffel, 2005; & Tawana, 2009). This review show that in general, case studies are preferred strategies when the 'how' and 'why' questions are being posed (Basse, 1999; Yin, 1994). This seemed relevant for this study to use a case study looking at sub questions of the research study as stated above. Case study method allowed for an understanding of teachers' conceptions about practical work to be studied in a holistic manner within a real life situation.

3.4 PARTICIPANT SELECTION

Participant selection, the sampling used in this study, is important in research as it is often difficult to study an entire population (Cohen et al., 2007). Sampling is the process or technique of selecting a suitable participant or subject, identified as a representative part of a population from which data is collected (Paton, 2004). According to Paton (ibid), population is a group of individuals, persons, objects, or items from which samples are taken for measurement. The purpose of sampling is to draw conclusions about populations from samples. Furthermore it is cheaper and is not time consuming to work with a sample than with the whole population (Paton, 2004). Most qualitative studies focus on smaller samples rather than upon large random samples.

In this regard, sampling was done by selecting two teachers from the group of teachers who are studying towards an Advanced Certificate in Education (ACE) for Physical Sciences in the Empangeni District within the Zululand Region. To register for an ACE, a teacher must have a three year teaching diploma in their chosen subject. During the first contact session teachers had to submit their profiles. After analysing their profiles I made the representative selection of two

Grade 11 teachers (Stake, 2005). This was purposive sampling (Cohen et al., 2007) as the researcher selects to cover a range of potentially relevant sources of information. The literature also reveals that most qualitative studies use purposive sampling (McMillan & Schumacher 2006). According to Paton (2004) purposive sampling selects information rich cases for in depth study. Cohen et al. (2007) add that in many cases purposive sampling is used in order to access knowledgeable people, for example, those who have in-depth knowledge about particular issues, maybe by virtue of their professional role, power, access to networks and experience or expertise. Both teachers received Grade 10 and 11 training for NCS conducted by Subject Education Specialists.

At the same time these teachers were chosen using convenient sampling method (Cohen et al., 2007 & McMillan & Schumacher 2006). According to Cohen et al. (2007, pp. 113-114) convenience sampling “is a way of choosing the nearest individuals until the sample is obtained or the choosing of individuals that happened to be available and accessible.” Convenience sampling was used because the participants could be assessed easily in the schools in which they teach and also due to ease of accessibility. In addition, being a tutor on the programme gave me access and allowed a development of trust to take place between the participants and the researcher. I maintained open-mindedness and skills in eliciting information from teachers. I put the teachers at ease by explaining that my role was of a researcher not a tutor and the information they provide will not be used against them.

3.5 DATA COLLECTION METHODS

Data collection involves the gathering of information about the case in the study (McMillan & Schumacher, 2006, p. 340). Data collection is a vehicle through which researchers collect information to answer their research questions and base their explanation on the data collected. The main instruments used to collect data in this study were pre-observation interviews (Appendix A1) and post-observation interviews (Appendix A2) and classroom observations (Appendix B). Some of the questions in the pre and post interview schedule were sourced from interview schedules in the study by Pekmez et al. (2005) on the teachers’ understanding of the

nature and purpose of practical work. According to McMillan and Schumacher (2006), interviews and observations techniques are usually associated with approaches of qualitative research. The choice of the type of data collection instrument for the researcher was based on its ability to answer the questions under exploration. Data collection was done through triangulation that is using two different instruments of data gathering. The interviews and classroom observation used together achieved a high degree of authenticity.

3.5.1 Interviews

Gillham (2000, p.1) defines an interview as “a conversation where one person the interviewer is seeking responses for a particular purpose from the other person the interviewee.” Adding evidence to this, Cannel and Kahn (2005) suggest that an interview is a conversation that is initiated by the interviewer for the specific purpose of obtaining research relevant information from the interviewee. I used interviews in this study for their advantages and purposes. According to Cohen et al. (2007, p. 350), one advantage of the interviews is that “it provides access to what is inside a person’ head which makes it possible to measure the knowledge or information, values and preferences as well as attitude and beliefs.” Patton (2004) further maintains that interviews emerge to determine data that cannot be observed, and that data can be matched to individuals and circumstances. Cohen et al. (2007) also state the purpose of interview is to engage with people in conversation face to face and gain direct access to their thought.

The type of interview used in this study was semi-structured. Semi-structured interview is the combination of structured and unstructured interviews, with a set of predetermined questions, but which allows for further probing and clarification of ideas (Opie, 2004). Semi-structured interviews were chosen because they are less formal, but a better way of capturing the point of view from participants. Adding evidence to this, McMillan and Schumacher (2006) indicate that establishment of trust, eye contact and being genuine are amongst the factors that helps to elicit more valid data than a rigid approach might. Semi-structured interviews are flexible, which contributes to yielding more information. The semi-structured interview uses open-ended questions to ensure consistency and allowed the teachers to talk freely about their own

experiences. It also gave the interviewer an opportunity to probe further if necessary without offending the interviewee (Cohen et al., 2007). In this way, the teachers as main interviewees were able to provide access to feelings and understanding as compared to the information that could be accessed through structured interviews. The interviews were conducted in the laboratory, because the interviewees thought the laboratory to be an appropriate place due to its quietness. Before the interview commenced, the researcher broke the ice by engaging the interviewee in small talk in order to create a comfortable atmosphere. The interviews with the teachers lasted up to 30 minutes. The interviews were conducted in English (see Appendices A1 and A2).

Regarding this study, a pre-observation interview was conducted before classroom observation in order to elicit teachers' understanding about practical work, which included definition, purpose and the types of practical work. Post-observation interview was a follow up after classroom observation for teachers' decision making. This included questions that asked for the reasons for choosing the particular type of practical work. The post-observation interview gave information on the reasons and justification for that particular instructional practice. The post interviews with the teachers lasted up to 50 minutes.

3.5.2 Classroom observation

The method used to collect data on teachers' use of practical work and their instructional practice was classroom observation. Classroom observation was used because according to Cohen et al. (2007), classroom observation enables the researcher to collect information on the physical setting, human setting, and interactional setting. After pre-observation interview, each of the teachers was observed during the lesson on the instructional practice. The lesson was sixty minutes long. The classroom observation provided rich findings on how teachers use practical work in their teaching. The disadvantage of classroom observation includes researcher bias, which means that researchers may see what they want to see. To reduce bias, I used the modified Millar's (2009) framework of the Practical Activity Analysis Inventory (PAAI). The modified PAAI instrument (Appendix B) was used to observe teachers' actual practice using practical

work. The PAAI instrument is a tool to be used to look at the effectiveness of practical work in teaching and learning (Millar, 2009). According to Millar (2009, p. 6), “the way a practical activity is designed and presented may have significant influence on the extent to which its learning objectives are attained.” Classroom observations have been used by many researchers to explore interactions between teachers’ conception of practical work and their actual instructional practice (Dlamini, 2008; Pillay, 2004; Stoffel, 2005 & Tawana, 2009).

3.6 DATA COLLECTION PROCESS

Data collection took place during the second term during the month of July and August. When I visited the schools I had a letter from the Department of Education (Appendix C1) and the ethical clearance certificate (Appendix D) from the university which granted me the permission to conduct a study. It is important to note here that the data collection took place without any intervention, and so teachers were to do things their normal way. That is, teachers had to do things the way they would have done without a researcher in their classrooms. During the interviews, I consciously reduced my own input so that the bulk of what was said would be contributed by participants, thereby minimising bias. The interviewees were allowed sufficient time to give their responses, and interrupting them was avoided so that they would not forget what they wanted to say. The interview data was audio-taped with consent from the interviewees. The audio-taping allowed for a smooth flow of the interview proceedings and increased accuracy and objectivity of the data collection (Cohen et al., 2007). Field notes were taken during the interviews, as the back up of the information obtained on audio-tape, which helped during the transcription process. See appendix for a copy of the field notes. Interviews were transcribed and each teacher given a copy of his or her transcript. Teachers were asked to read their transcripts and contact the researcher should they wish to amend or clarify the meanings of their verbal comments.

Another data collection strategy used was classroom observation. There were two classroom observations per teacher. The lesson period lasted for an hour (60 minutes). Observations mainly focused on classroom instruction and learning activities. On the instructional strategies, I used a

modified PAAI framework. During classroom observation I chose a place in the laboratory where most of the teachers' and learners' activities during the lesson could be seen and also minimize the distractions for learners. One disadvantage of a classroom observation is that the presence of the observer can affect the normal behaviour of those being observed. To reduce this 'observer effect', arrangements were made with the teachers to inform their learners of the researchers' visit, and I visited the school twice on classroom observation.

Lesson preparation and practical work worksheets were checked for their authenticity but not analysed or interpreted. I looked at how the teachers prepared for the lesson, lesson plan and the subject matter delivery activity that they had devised. It was important to look at the lesson plan or practical work task report during observation since that can provide information and clarify the collective educational meanings that may be underlying the current practices of Physical Sciences teachers. However, the purpose of the study was on teacher's understanding and practise of practical work elicited through pre- interview, post-interview and classroom observation. In the light of the above statement documents did not form part of data collection instrument.

3.7 DATA ANALYSIS

Data analysis is a process of inspecting, cleaning, transforming and modelling data with the goal of highlighting useful information, suggesting conclusions and supporting decision making (Hatch, 2002). According to Leedy and Ormrod (2005) method of data analysis in a case study design can be undertaken by categorisation and interpretation of data in terms of common themes. It is on that point that Guba and Lincoln (2005) suggest that all data collected requires reading and re-reading in order to develop the clearest picture.

After a respondent validation process I engaged in the process of data analysis. The inductive qualitative content analysis was used. According to Thomas (2003) the purpose of the inductive approach analysis is to condense extensive and varied raw text data into a brief, summary format

and to establish clear links between the research objectives and the summary findings. Adding evidence to this, McMillan and Schumacher (2006) affirm that qualitative data analysis is an inductive process of organising data into categories and identifying patterns or relationships among categories.

I initially analysed the data for each case, each teacher separately, noting the teachers' understanding of practical work, the types of practical work, how the teacher conducted practical work and why the teacher used that type of practical work. After that a comparison was made to answer the research question. The analysis and findings are discussed in detail in chapter 4 and 5 respectively.

3.8 TRUSTWORTHINESS

The terms trustworthiness and authenticity have replaced the terms reliability and validity, which are the terms that have been traditionally used to assess quality of quantitative research (Guba & Lincoln, 2005). According to Guba and Lincoln, trustworthiness is addressed through richness and scope of the data achieved, honesty, depth, the participants' approach and the extent of triangulation while authenticity is concerned with the wider political impact of research. Trustworthiness is made up of four criteria: credibility, transferability, dependability and conformability (ibid). Credibility is the feasibility of the findings which can be ensured through triangulation. In this study credibility was ensured by method triangulation and respondent validation.

According to Paton (2004), triangulation is a strategy to assess the truth value of a study. Cohen et al. (2007) also describe triangulation as the use of two or more methods of data collection in the investigation of some aspect of human behaviour. The collected data from different instruments is then compared and contrasted. In this study, triangulation was achieved through the combination of two instruments, pre and post observation interviews and classroom observation of teachers using practical work. In combining these multiple methods, the

researcher hoped to overcome the weakness or intrinsic biases and the problems that can come from using a single method. Triangulation was an effective way of making more comprehensive data. The other way to ensure credibility is through respondent validation (Guba & Lincoln, 2005).

Credibility can be achieved if the participants understand and interpret the findings of the study in the same way as the researcher (Guba & Lincoln, 2005). In this study the credibility was enhanced by returning interview transcriptions to the participants for verification. Respondent validation is regarded as the technique critical to establishing trustworthiness in a case study research (ibid). Also, the research data and findings were discussed with the participants and supervisor to ensure that the interpretation of data is not different from mine. On the one hand, conformability refers to the objectivity of data which ensures that the research's findings are the results of the experiences and ideas of the participants rather than the preferences of the researcher (Guba & Lincoln, 2005). This was addressed in this study as I audited the research process under the supervision of the supervisor.

Transferability is concerned with the extent to which the findings of one study can be applied to other situations (Guba & Lincoln, 2005). The findings of this study were specific to two Physical Sciences teachers, which makes it difficult to demonstrate that the findings are applicable to other population. I overcame that by providing the background data and detailed description of the case to allow comparison to be made. Moreover, I gave an in-depth research design and methodology to allow for the study to be repeated. This addresses the dependability of the study which refers to the stability of data over time and over conditions (Paton, 2004). This means that if the research was repeated with the same design and participants, similar results would be obtained.

Authenticity is concerned with the wider political impact of research, which features fairness (Guba & Lincoln, 2005). This means that the process of the whole study must be carried fairly.

This suggests that the emphasis on authenticity is on the practical outcome of the research. So the whole process of this study was grounded on the ethical principles about issues of sampling, data collection procedures and data analysis.

3.9 ETHICAL ISSUES INVOLVED

Ethical issues are a matter of principled sensitivity to the rights of others, and while truth is good, respect for human dignity is better. According to Cohen et al. (2007) it is important that ethical issues are addressed since they play a fundamental role in research. I needed to be aware of ethical issues as the study took place among teachers. I adhered to the ethics guidelines as described by the KwaZulu-Natal University ethics committee to guide the study. Permission from the ethics committee was granted to conduct the study. I obtained ethical clearance from the University of KwaZulu-Natal (Appendix D). I then obtained permission to conduct research in schools from the Department of Education of KwaZulu-Natal (Appendix C1). The Empangeni District Office received the letter for application and gave me the permission to conduct research. The principals of each of the schools signed informed consent letters (Appendix C3). The two Physical Science teachers signed informed consent letters (Appendix C1). I also explained to the teachers in my sample that they were free to read my analysis of the data collected.

I ensured that the rights, confidentiality and dignity of teachers were protected. Confidentiality was important since teachers revealed that they do not wish to have their understanding and feelings publicised. My role was to make sure that the participants identity is not revealed in the final write up of the study. The identity of participants was protected by using pseudonyms to ensure anonymity. The participants used in this study were informed volunteers and were aware that their responses would be used for this thesis. The participants were aware of their right to withdraw from the study or not to participate if they so wished.

3.10 LIMITATIONS OF THE STUDY

I understand that there are strengths and limitation in the study. There were few limitations as far as the study is concerned. Using data collection methods associated with qualitative research design was time consuming. However, the use of these methods pre and post semi-interviews together with observing actual practice helped me with the findings in answering the research question. On the other side, the process of data analysis was labour intensive. The sample in this study was small, which put to question its generalisability. This is a frequent criticism of the case study methodology that it cannot provide findings that are generalisable (Yin, 1994). The findings of this case study may be informed by a teacher's background or the school context which might not apply to other cases. The study was limited to two schools in the Empangeni District and with two teachers due to time constraints which will make it difficult to make generalised findings. The study took place during school hours for classroom observations, which created a problem for me as a researcher, because I am a full time teacher. I had to take some time off from school in order to attend to my study at these other two schools.

3.11 CHAPTER SUMMARY

This chapter explains the research design that was used to explore Grade 11 teachers' conception of practical work, as well as how these shape the way that the teacher conducts practical work. I have described the research methodology, research methods, research procedures, sampling, trustworthiness and ethical considerations. In chapter four the collected data is analysed.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter will focus on the analysis of the data collected through pre and post semi-structured interview and an observation schedule to explore Grade 11 teachers' conception of practical work in Physical Sciences within the NCS curriculum. This case study has allowed me to capture a rich insight into Grade 11 teachers' understanding, their practice and the justification of their instructional methods for teaching practical work. The teachers' understanding of practical work, classroom practices and the reasons for that classroom practice were the main focus of data organisation and analysis.

The data was analysed qualitatively in order to get in-depth information on teachers' conception of practical work. The qualitative data obtained, mainly from pre and post semi-structured interviews were manually analysed. Firstly, the recorded interviews were transcribed from the audio tape recorder onto the paper. The data was read over and over for me to be familiar with the content of the responses so that I could identify key ideas. Another reason for re-reading the responses was to look for themes in the pre-interview, with observation schedule analysis and also the post-interview with the observation schedule analysis.

The interview responses were to be interpreted in a way that did not compromise the original meaning expressed by two Grade 11 teachers, Shrandá and Clara. Qualitative content analysis was chosen for its power to make such inferences. As suggested by Patton (2004), qualitative content analysis involves qualitative data reduction and sense making effort that takes a volume of qualitative material to identify core consistencies and meanings. The analysis process was inductive. Inductive content analysis involves organizing qualitative data, which includes coding, creating categories and abstraction (Elo & Kyngás, 2008). The categories emerged on their own

as I read the interview transcripts. From that point, categories of analysis were drawn to make it easy to identify similarities and differences that emerged from the participants' responses.

The data will be presented in two stages. The first stage will be data presentation case one for Shranda, followed by case two for Clara. The data presentation will then be followed by the analysis of the two cases. The discussion of the individual responses includes quotations from pre and post observation interviews transcripts and instructional practice of teachers. The final discussion of this section will provide the overall findings on the teachers' understanding of practical work and insight into their PCK for practical work.

4.2 CASE ONE: SHRANDA'S CASE

4.2.1 TEACHERS' BACKGROUND

Before presenting and analysing the responses of participants, it is important to provide a description of the school context focusing mainly on Physical Sciences teaching and learning and the teachers' background. The teacher might mention factors such as the school resources, number of learners per class as contributing factors to the way practical work was conducted.

4.2.1.1 Shranda's school context

The school is located at the outskirts of a semi-rural area in Empangeni. This is a large school with an enrolment of 1563 learners from Grade 8 to Grade 12 and 49 teachers including the principal. There are seven sections in Grade 11 and from those seven sections there are two Physical Sciences classes with learners ranging from 55 to 60. There are only Black African learners in the school. The school has one library, which is not operational because there is no librarian. Learners cannot use the school library to do their research projects. There is one laboratory. The laboratory is used for science subjects like Physical Sciences and Life Sciences. One can see that the laboratory is used even though it is under resourced. The school is under section 21, where the Department of Education will subsidise the school and the school takes full responsibility of the funds.

4.2.1.2 Shranda's background

Shranda is a female Black African teacher who has 15 years of experience teaching Physical Sciences at FET phase (Grade 10-12). Shranda has a Senior Teachers Diploma (STD) with majors in Mathematics and Physical Sciences from Esikhawini College of Education. Shranda teaches Grade 10 – 12 Physical Sciences in a government secondary school. Shranda is currently registered with the University of KwaZulu-Natal enrolled for Advanced Certificate in Education (ACE), Physical Science.

4.2.2 UNDERSTANDING OF PRACTICAL WORK

The first critical question explores the understanding of practical work from teachers. To elicit this understanding a semi-structured interview was used. The semi-structured interview was conducted on the 26th of July 2011 (Appendix E1). The following categories were used:

- Definition of practical work
- Importance of practical work
- Purpose of practical work
- Types of practical work that teachers used

Below is the presentation of the results supported by the comments of Shranda's case.

4.2.2.1 The meaning of practical work

Shranda was asked what she understands by the term practical work. Shranda gave the following definition of practical work:

Practical work is the activity done by the teacher or by pupils themselves using apparatus to reinforce what they have learnt in class. It helps pupils to understand scientific ideas. During practical work pupils are engage in an experiment to prove a particular theory or law. Practical work is the activity that gives pupils a chance to act like a scientist and be able to solve problems. (Line 8-12).

Shranda indicated the understanding of what practical work is. Shranda's explanation of practical work gave the idea that it is a teaching and learning approach that is used to reinforce what was learnt in class. Shranda stressed the active participation of learners in the activity. This is evident from the explanation of practical work that she gave, because every activity during practical work is done by learners. Furthermore, Shranda indicated that "practical work is the activity that gives pupils a chance to act like scientist and be able to solve problems." (line14-15). Acting like a scientist in practical work helps learners to develop the skills of good scientists, like planning an investigation.

4.2.2.2 The importance of practical work

The teacher was asked for the reasons for including practical work in the teaching and learning of Physical Sciences. Shranda's response revealed she believes that practical work is of value in Physical Sciences. This is taken from this statement during pre observation semi-structured interview:

I think practical work is important because it helps pupils to learn Physical Science or understand the subject better. Pupils understand some Physical Science concepts better when they see things happening. This means that practical work makes abstract ideas to be more real or concrete [sic] (line 15-18).

Shranda considered the value of including practical work in the teaching and learning of Physical Sciences. Shranda viewed practical work as a strategy that helps learners to learn science concepts because it makes abstract ideas concrete. For Shranda, practical work was important because it reinforced the theoretical concepts of Physical Sciences. Shranda demonstrated the understanding of practical work and was committed to using practical work in teaching of Grade 11 learners. When asked how frequently she uses practical work, the response was that she undertook probably six demonstrations, even though the programme of assessment for Grade 11 requires only two practical investigations.

4.2.2.3 Purpose of practical work

It is also evident that Shranda believed that practical work is an instructional strategy to be used in Physical Sciences teaching and learning. Shranda said:

..the purpose of practical work will be to expose pupils to meaningful learning where they will observe what is happening during the experiment, collect apparatus and feel them. During practical work pupils will get a deeper understanding of the theory. In fact, the purpose of, practical work is to involve pupils and to give them a chance to observe by themselves, encourage accurate observations collect, analyse data and reach conclusions. Practical work is supposed to enhance the scientific knowledge of pupils. The curriculum states that practical work should develop process skills in pupils. (line 27-34)

Shranda's purpose of practical work can be categorised into learning Physical Sciences better and learning and developing practical skills. The category for motivation or enjoyment can also be added here because Shranda mentioned during the interview that "It also makes pupils love and enjoy Physical Science, for example in our school most pupils will choose Physical Science as a subject because they want to do practical work. They want to go to the laboratory." (line 18-21). So, Shranda's response included procedural understanding as another purpose of practical work.

4.2.2.4 Types of practical work

When asked about the types of practical work, Shranda gave this response:

...but I will say experiments, demonstrations and err practical investigations which are required by the curriculum... I usually used demonstrations when I am teaching. Demonstration helps me if I want to prove a particular concept for my pupils or verify particular concepts in the lesson...[sic] (line 36-37).

From the data gathered from these responses it was evident that Shranda knows different types of practical work. However, Shranda used demonstration for teaching Physical Sciences. The

knowledge of different types was extended because for Shranda, different types of practical work have different purposes. Shranda's supporting statements:

they can have different purposes for example demonstrations cannot serve the purpose of developing pupils skill because pupils are not hands-on. I think practical investigation is the type of practical work that develops pupils' process skills (line 40-42).

Upon examination one can see that Shranda mentioned that there are various types of practical work that are conducted in the laboratory. However, surveys and fieldwork are not mentioned.

4.2.3. TEACHER CLASSROOM PRACTICE

This question explored the pedagogical issues related to practical work and actual nature of activity in the Grade 11 Physical Sciences classroom. The summary notes revealed what was going on in the laboratory on the 28th of July 2011(Appendix F1).

4.2.3.1 Summary of Shranda's classroom practice of practical work

Shranda introduced the topic to be presented and then asked questions based on the previous lesson. The previous lesson was based on the introduction of electric circuits. The discussion was on series and parallel connection of electric circuits. After questioning the learners and learners responding to questions, she then introduced the lesson. The topic that was written on the board was Ohms' Law. Shranda explained the law by stating when and how the law is used by learners. She added that the law would be explained through the experiment. She told learners that she was going to demonstrate and they must observe so as to be able to draw conclusions. The aim of the experiment that Shranda wrote on the board:

To investigate the relationship V/I for various potential differences across a metallic conductor if the temperature remains constant.

Shranda also wrote down the objectives that she wanted learners to achieve after the practical work. The lesson objectives were:

- Draw a graph showing the relationship V/I
- Determine the resistance of a given metallic conductor

In Shranda's class there were 55 learners. Before she started with the demonstration she tried to ensure visibility of the demonstration. Before the demonstration she showed learners each apparatus that she was going to use and explained the purpose of each apparatus. When she was connecting the circuit she told learners what she was doing. Learners were watching. Shranda tried to hold their attention by involving learners during the demonstration asking questions like:

What am I doing now?

Learners' response:

Connecting the cells madam.

When it was time to take the readings she drew the table on the board and asked learners to copy the table on their exercise books. The table looked like this:

	Current	Potential difference	Ratio V/I
1			
2			
3			
4			

Shranda continue with the demonstration and took the readings for learners. The readings were written on the board and learners were allowed to copy them.

After the demonstration, learners were asked to use the values to draw the graph. Learners were given graph paper and they started working on drawing the graph. Learners were working in groups of four. Shranda was moving around assisting learners with choosing the scale and any other questions that were raised. After every group had finished drawing the graph the class was involved in discussion through the use of question and answer method. The following questions guided the discussion:

- What happens with the ration V/I
- What can be concluded from the shape of the graph of V vs. I ?
- What is the relationship between V and I ?
- Indicate the relationship mathematically.
- What property is indicated by V/I ?
- Whose law is demonstrated?

The post demonstration discussion was important because this is where Shranda broadens the learners understanding about Ohms law. Using question and answer method, she checked whether learners had understood the content. During the concluding phase, Shranda explained how this lesson would link to the future lesson, when they will be doing calculations.

4.2.4 LINKING UNDERSTANDING AND PRACTICE

After the classroom observation, it was important to get the responses to establish the teachers' pedagogical knowledge on the issue of practical work. The post semi-structured interview was conducted on the July 29, 2011 (Appendix E2). To succeed in getting this information, the participant was asked for

- Justification for using practical work in the lesson,
- Purpose served by practical work in the lesson,
- Reasons for using demonstration as the type of practical work
- Willingness to change.

Below is the presentation of the results supported by comments from the teachers. Shranda's results are given, followed by results for Clara.

4.2.4.1 Justification for using practical work

Shranda's response when asked why she used practical work in her lessons, revealed that she conducted practical work to enhance the understanding of concepts to the learners. Shranda conducted demonstration for learners to understand Ohms law. This is supported by the following statements by Shranda:

In this lesson I wanted my pupils to understand and be able to state Ohms law. I gave them an opportunity to observe the relationship between the current and potential difference, represent the collected data on the graph and interpret the graph to reach conclusion (line 82-86).

4.2.4.2 Purpose served by practical work in the lesson

During the pre-interview, Shranda mentioned that different types of practical work have different purposes. According to Shranda demonstrations were used to prove or to teach particular concepts. This is evident when she linked the purpose of the lesson to the type of practical work that is demonstration during their lesson. This suggests that according to Shranda sometimes the purpose of practical work influences how practical work is conducted. This is the reason provided by teacher Shranda:

Hhmm..I will say yes because I have used demonstration to help pupils know about the relationship between current and potential difference that is Ohms law. The whole class recorded the readings and was able to draw the graphs (line 90-94).

Shranda agreed that the outcomes of the lessons were achieved. Shranda commented:

Oh yes, I think the objectives were achieved because learners were able to draw a straight line graph which implies that increasing the potential difference results in

an increase in current and they were able to interpret and draw the conclusion from the graph they have drawn (line 102-106).

One may suggest that for Shranda in her lesson, for learners to be able to achieve the outcomes was that she communicated the purpose of the activity to learners prior to the demonstration. Clarifying this point, Shranda said that:

Yes, they were aware because when I introduced my lesson, I did mention that I will be doing the demonstration on the relationship between the current and the potential difference and I want them to record the ammeter and voltmeter readings so that they will draw a graph (line 109-113).

4.2.4.3 Reasons for using demonstration as the type of practical work

Responding to the question of why she chose demonstration from amongst all other types of practical work, Shranda cited several factors for choosing demonstrations as the type of practical work to use in teaching Physical Sciences. Amongst the factors she mentioned are time factors, large classes, lack of resources, ease of demonstration, content coverage, and demonstration yield to correct results. Shranda had this to say:

It is easy to demonstrate because I don't waste time. I demonstrated Ohms law over a single period. I tried to do the demonstration correctly so that I get the correct results to verify what we were learning about in this case Ohms law. I do it myself because sometimes pupils cannot even take a reading on the ammeter and voltmeter. My objective when doing demonstration was for my pupils to make observations so that they can see relationships between the current and potential difference. In other words, I did a demonstration to help my pupils understand this particular scientific concepts or law. Another reason I chose to do a demonstration is that investigations are time consuming because when pupils do their own experiments they sometimes do not get the desired or correct results so they keep on trying. Some investigations cannot be done over a single period and the Grade 11 curriculum is too long to waste time doing investigation. I am under

pressure to cover the content and prepare learners for exam. You know, pupils make lots of mistakes when working in groups doing experiments. It is difficult to explain to them why they don't get correct results. And pupils will think I don't know Physical Science if I don't give them answers (line 117-137).

4.2.4.4 Willingness to change.

Shranda displayed willingness to change the way she had conducted her practical work if given a chance to do so. Shranda mentioned that she will change the type of practical work from demonstration to investigations, which are inquiry based practical work. Commenting on the willingness to change, teacher Shranda said:

I will change the type of practical work from demonstration to investigation. I will allow pupils to do the practical work for themselves. It is good for pupils to discover things for themselves while engaging in hands-on activities. When pupils discover things for themselves they do not forget easily. My work as the teacher will be to design practical work in a way that encourages pupils to discover for themselves. The Physical Sciences documents encourage pupils to conduct investigations so that they can develop interpretive and process skills. But under the circumstances I am forced to do demonstration because there are not enough laboratory equipments. We do have the laboratory, but it lacks resources (line 155-166).

4.3 CASE TWO-CLARA'S CASE

4.3.1 TEACHERS' BACKGROUND

Before presenting and analysing the responses of participants, it is important to provide a description of the school context, focusing mainly on Physical Sciences teaching and learning, as well as the teachers' background. It was imperative that the teachers' background and school context is discussed. The teacher might mention factors such as the school resources, number of learners per class as contributing factors to the way practical work was conducted.

4.3.1.1 Clara's school context

The school is located at Esikhaleni Township in Empangeni. There are only Black African learners in the school. This is a large school with a principal, two deputy principals, five HOD's and 23 teachers. The school has the enrolment of 1055 learners from Grade 8 to Grade 12. The school does not have enough classrooms for such enrolment. There is a computer room which is used to teach Computer Application Technology (CAT). There is one laboratory that is functioning but not well equipped. Grade 11 learners doing Physical Sciences as the choice subject are grouped together with learners that are doing accounting. When it is Physical Sciences period learners have to move out of the classroom and go the laboratory, leaving accounting learners behind.

4.3.1.2 Clara's background

Clara is a Black African female teacher who has 17 years of experience teaching Physical Sciences at FET phase (Grade 10-12). However, Clara has been in this school for 4 years as a Head of Department (HOD). So she performs administrative duties as well as teaching and assessment. Clara has a Secondary Teachers Diploma (STD) with majors in Physical Science and Mathematics from Eshowe College of Education. Clara teaches Grade 11 and 12 Physical Sciences, and Grade 9 Natural Sciences in a government secondary school. Clara is currently registered with the University of KwaZulu-Natal, enrolled for an Advanced Certificate in Education (ACE), Physical Science.

4.3.2 UNDERSTANDING OF PRACTICAL WORK

The first critical question explores the understanding of practical work from teachers. To elicit this understanding, a semi-structured interview was used. The semi structured interview was conducted on the 15th of August 2011 (Appendix E3). The following categories were used:

- Definition of practical work

- Importance of practical work
- Purpose of practical work
- Types of practical work that teachers used

Below is the presentation of the results supported by the comments of Clara's case.

4.3.2.1 The meaning of practical work

Clara indicated that: "according to my understanding practical work is a hands-on activity or you can say that is something that learners do using the apparatus." (Line 8-10).

From this short definition I probed further for clarification of what hands-on activity is. Clara's response was, "by hands-on I mean that is where pupils they handle the apparatus and manipulate them and after doing the experiment is where they can may be draw conclusions." (line 12-14).

Clara's explanation regarded practical work as 'hands-on activity'. Clara's idea of practical work also stressed the participation of learners in manipulating apparatus until they can conclude from their observations. However, the idea of hands-on for Clara is confined to handling and manipulating apparatus during the experiment.

4.3.2.2 The importance of practical work

Clara agreed that practical work should be used in teaching and learning Physical Sciences. She stated the following reasons:

I think practical work is important when I teach Physical Science because it makes the concepts to be more real not abstract when pupils are hands-on doing experiments. Let us say for example like our Grade 11 we have the concept like titration in acid and base it become difficult to teach that concept to learners so the best thing is to do the experiment with learners where they will be observing during the titration where may be there is a colour change and they will looking at

the reaction and they will be observing the end point. There are some experiments like Boyles law. When you want to explain and emphasise may be to allow learners to draw some graph you can't just teach them you make them to do the practical and take some readings so that they can make their conclusions and draw the graphs (line 17- 27).

The main reason given by Clara, through the examples provided, on the reasons for including practical work in teaching Physical Sciences, revealed that practical work helped learners to understand facts and concepts as it made the phenomena more real.

4.3.2.3 The purpose of practical work

This is Clara's response on the purpose of practical work:

Practical work it helped teachers and learners. It helped teachers to make it clear on what they are teaching and it contributes to learners the understanding of the content. It makes learners to be able to do practical work, to do the measurements and to enjoy to be in the lab to see themselves as scientists. And it also helps them to be able to interpret what they have observed during the experiment and after that to draw some conclusions (line 30-35).

The purpose of practical work in Physical Sciences according to Clara can be for learning better, developing practical skills and for enjoyment. According to Clara, even teachers benefit from practical work, because teachers used practical work as a tool to help learners understand Physical Sciences concepts.

4.3.2.4 Types of practical work

Clara had this to say about the types of practical work:

There are different types of practical work that I know the first one like investigations err...and there is another one which is called illustrations and demonstrations (line

37,38)... in most of the cases I use to demonstrate because we have the shortage of apparatus and the classes are overcrowded so it's easy for me to use demonstration.(line 50-52).

Upon examination one can see that Clara mentioned the types of practical work that are confined in the laboratory. The other category of practical work mentioned in chapter 2, complementary activities which includes surveys and fieldwork, is not mentioned.

The knowledge of different types was extended because for Clara, different types of practical work have different purposes. Clara said :

...different practical work has different purposes. For example practical investigation or experiments can be used to develop practical skills like accurate measurement and allow learners to be able record what they have seen during the experiment. When it comes to demonstration, one cannot develop practical skills because it is used by a teacher so the learner when they use the practical investigation they have the hands-on (line 42-47).

Clara demonstrated the understanding of practical work and was committed to using practical work in teaching of Grade 11 learners. However it is worth noting that from that understanding Clara had, she still preferred to use one type of practical work - namely that of demonstrations - out of all the other types.

4.3.3 TEACHER CLASSROOM PRACTICE

This question explored the pedagogical issues related to practical work and what actually goes on in Grade 11 Physical Sciences classrooms. The summary notes revealed what was going on in the laboratory on the 17th of August 2011(Appendix F2). Summary notes for Clara.

4.3.3.1 Summary of Clara's classroom practice of practical work

During the introductory phase, Clara determined the knowledge that learners had acquired during the previous lesson using a question and answer method. The previous lesson was on the types of reactions. Learners have studied the types of reactions for inorganic substances like redox and acid and base reactions. Clara then formulated the problem asking about the reactivity between alkanes and alkenes and the type of reaction undergone by alkanes and alkenes. Clara then presented the background to the problem posed to learners. Clara mentioned that to answer the question posed she will do the demonstration. Clara told learners that she would do the demonstration due to lack of apparatus. She gave learners the worksheet with the topic, aim of the experiment, objectives, apparatus, method, table for results and conclusion. The aim of experiment was to investigate the reactivity of alkanes and alkenes. The worksheet had questions that learners have to answer before demonstration, for example:

- Formulate the investigative question for this experiment
- Write down a possible hypothesis for the experiment
- Write down TWO safety precautions that must taken during the investigation
- Why is there a need to pour equal amount of cyclohexane and cyclohexene

Learners worked individually to complete the worksheet. Clara explained the timing of each activity. There was a stipulated time for completing the first section of the worksheet. The responses were discussed as the whole class.

The next phase was a teacher demonstration. Clara tried to ensure visibility even though the apparatus were small. Learners were to observe and complete the worksheet. This is an example of the table that learners had to complete:

Compound	Action of liquid bromine in the dark room	Action of liquid bromine in sunlight
Cyclohexane		
Cyclohexene		

After the demonstration, Clara discussed results by means of question and answer method. Clara gave learners a chance to draw their own conclusion from demonstration. The concluding phase was for learners to answer some of these questions:

- What conclusion should learners reach about the reactivity of the above compounds?
- Explain this conclusion.
- Write down the balanced equations using structural formula for the reaction between:
 - Cyclohexane and bromine
 - Cyclohexene and bromine

At the end of the lesson Clara highlighted the major points and gave feedback on the completed worksheet.

4.3.4 LINKING UNDERSTANDING AND PRACTICE

After the classroom observation, it was important to get the responses as to why teachers conducted practical work in the way that they did. The aim was to find out their pedagogical knowledge on the issue of practical work. The post semi-structured interview was conducted on the 18th of August 2011(Appendix E4). To succeed in getting this information participant was asked for

- Justification for using practical work in the lesson
- Purpose served by practical work in the lesson
- Reasons for using demonstration as the type of practical work
- Willingness to change

Below is the presentation of the results supported by comments from the teachers. Shranda results are given followed by results for Clara.

4.3.4.1 Justification for using practical work in the lesson

Clara used demonstration during her lesson. And when asked why she used that type of practical work, this was her response:

I used practical work when I was explaining reactions. It will not be easy for pupils to understand the difference between addition and substitution reactions. Practical work was important to demonstrate that alkanes have slower reactions than alkenes. The purpose of the practical activity in this lesson was for pupils to be able to differentiate between substitution and addition reactions (lines 81-87).

Clara's justification for using demonstration in her lesson was that of achieving substantive understanding.

4.3.4.2 Purpose served by practical work in the lesson

Clara had one purpose that she anticipated will be achieved during demonstration. Responding to the question on what purpose did demonstration serve, Clara said:

The purpose of the practical activity in this lesson was for pupils to be able to differentiate between substitution and addition reactions. Mam you saw I use cyclohexane and cyclohexene and bromine water (line 90-92).

On checking whether the purpose was achieved during demonstration, Clara responded:

Mam you were there you see that after demonstration the class observes that cyclohexane has a slow reaction with bromine water as compared to cyclohexene. So the purpose of practical work was achieved through demonstration. I can say yes to your question (lines 97-101).

Asking if the purpose of the activity was explained to learners, Clara said:

Yes, pupils were aware. I introduced the lesson by asking some few questions from the previous work from what they already know about hydrocarbons and

then I told them about the demonstration and what I want them to observe. The purpose of the activity was clarified to learners (lines 107-111).

4.3.4.3 Reasons for using demonstration as the type of practical work

Clara had demonstrated the understanding of different types of practical work with their purposes. Out of all the different types she used demonstration. The teacher was asked reasons for using demonstration. Clara had this to say:

Hmmm ... I chose it because demonstration is easy to make since I have big classes and I have a shortage of apparatus to make each of my learners to have a hands-on experiment. Even if I had apparatus it will be difficult to control each pupil or groups of three pupils due to big numbers. And the other thing that I can say is that is time consuming. Pupils do not finish the experiment during one period they will need more time may be two to three periods to finish this experiment. You know mam the syllabus for Grade 11 is too long so I can't risk time I must conserve time (line 115-124).

This justification of teacher Clara for using demonstration involves contextual and content factors. For example content coverage is a content factor while lack of resources and others are contextual factors.

4.3.4.4 Willingness to change

Teacher Clara's response was similar to that of teacher Shranda's and even Clara added that investigation is a curriculum requirement. This was Clara's response:

The experiment is easy and not dangerous. It will be good for pupils to be hands-on, so that they can touch apparatus like test tubes, and be able to improve their measuring skills and to take some volume equal volumes of cyclohexane and cyclohexane but it was a good experiment (line 136-140).

Probing further why it is good to be hands-on for learners. Teacher Clara responded:

it is good because some pupils can develop process skills of measuring and observing which is encouraged to pupils who are doing Physical Science. When pupils are hands-on they feel like real scientists. Another reason they will be conducting their own investigation. It is a requirement for Grade 11 assessments for learners to conduct investigations. So I think it is helping them to do the practical work (line 142-148).

Clara indicated the understanding of the requirement for continuous assessment for Grade 11.

4.4 CROSS CASE ANALYSIS

Below is an analysis of the results on the data that is presented above from both teachers. This analysis is supported by the literature.

4.4.1 TEACHERS' UNDERSTANDING OF PRACTICAL WORK

It is evident from the data presented that Shranda and Clara have understanding of practical work.

4.4.1.1 Shranda's case

Shranda's understanding of practical work is based on the notion that practical work is a teaching approach and at the same time is a learning tool. It is a teaching approach because teachers use practical work to make the Physical Sciences phenomena more real. Moreover, learners use practical work to prove Physical Sciences theories or laws. Shranda considered that engaging learners in practical work helps them to understand the facts and concepts of Physical Sciences. It is significant to note that according to Shranda, practical work also is an activity that helps learners to act like scientists. Hayward (2003) agrees that one of the reasons for including practical work in Science lessons is to help learners develop the skills of good scientists, amongst

which are the skills required in conducting investigations, careful observation, drawing logical conclusions as well as others.

According to Millar (2004) the purpose of practical work can be grouped into four major categories, the development of:

- Conceptual understanding
- Student interest and motivation
- Science process skills and technique
- Understanding of the nature of science and scientific inquiry

Using the Millar's categorisation, Shranda's purpose of practical work falls into three categories: student interest and motivation; conceptual understanding; and science process skills and techniques.

Shranda's types of practical work varied amongst demonstrations, experiments and practical investigations. It is clear that the knowledge on the types of practical work for Shranda is confined to the laboratory. Shranda did not mention the type of practical work that occurs in an out of school setting, for example fieldwork. From the different types of practical work possible, Shranda indicated that she prefers to conduct demonstrations. Pekmez (2005) indicates that most teachers prefer to conduct demonstrations.

4.4.1.2 Clara's summary

To Clara practical work is a hands-on activity where learners do experiments handling and manipulating apparatus. However Clara's definition of hands-on activities, did not include skills such as inquiry learning, creative thinking, problem solving and amongst the others designing experiments. Clara's definition pointed to the interaction of learners with material in order to draw conclusions. Furthermore, this definition highlights the participation of learners, where they are active during practical work and not simply passive. Clara revealed an understanding that when learning is hands-on, the Physical Sciences concepts being taught are made real or

tangible. This is corroborated in the literature where amongst the importance of practical work, Hayward (2003) mentions that it can make phenomena more real. Clara made mention of the importance of observation in practical work for learners to reach conclusions. Observation is a practical skill that is also important during practical work, because each learner will be likely to better understand phenomena he or she is able to observe. Consequently, it is a good way to assess what ideas they do have in their minds (Ross, Lakin, & Callaghan, 2004).

Comparing Clara's purpose of practical work to the Millar's categorisation, it falls into three categories: student interest and motivation; conceptual understanding; and science process skills and techniques. From the example that Clara gave, the emphasis on the purpose of practical work was on helping learners to understand the theoretical aspects of science.

Clara's varieties of practical work included demonstrations, illustrations and practical investigations. It is not surprising that Clara mentions illustrations because illustrations are used to support theory and consolidate knowledge (Pekmez et al., 2005). Clara stated that practical work helps teachers to make clear what they are saying. Given the fact that Clara viewed practical work as hands-on, she did not mention the type of practical work exercises that were used to develop a particular skill in learners (Pekmez, 2005).

4.4.1.3 Analysis of the two cases of teachers' understanding of practical work

Overall, the analysis of teacher responses revealed that teachers have wide understanding about the nature of practical work. Similarly, it can be seen that for Shranda and Clara understanding of what practical work is, in fact, the same. For both teachers, Shranda and Clara, definitions of practical work are limited to the activities that can be undertaken inside the laboratory or classroom. They left out those activities that are done outside the laboratory, for example field work.

Both teachers revealed understanding of the purpose of practical work in a similar way. Their understanding of the purpose of practical work falls into three categories: student interest and motivation; conceptual understanding; and science process skills and techniques. It is important to note that there is one category that was not mentioned by both teachers, that of understanding of the nature of science (NOS) and scientific inquiry. NOS and scientific inquiry promotes student ways of solving scientific problems (Millar, 2004). On closer examination, Clara mentions investigation as type of practical work but did not mention any purpose of practical work that pertains to investigation. My view of this is that Clara's understanding of investigation is limited. There is one familiar purpose of practical that was not mentioned by both teachers—namely that it helps to develop cross-curricular skills such as communication, friendship and working as team (Hayward, 2003; Pekmez, 2005). This raises questions as to how these teachers conduct or engage learners in practical work.

4.4.2 TEACHERS' CLASSROOM PRACTICE

The analysis of the teachers' classroom practices is based on the summary notes for their observation schedule. Both teachers used practical work in their lessons even though their school context indicated that their laboratories are under resourced. This agrees with findings by Hatting et al., (2007) that doing practical work is not significantly dependent on whether the teachers have physical resources, but those that are motivated will do so even in the most poorly resourced schools. Nevertheless, both teachers, Shranda and Clara, used demonstration in their lessons as the way of doing practical work. Pillay (2004) reveals from her findings that 94, 7% of teachers use demonstration as the main way of doing practical work. This is not a surprising finding as other studies reveal that teachers still prefer to use demonstration rather than inquiry-based practical work (Pekmez et al., 2005; Stoffel, 2005). However, Shranda and Clara differ in their approach to using demonstration. Shranda started with the theory, explaining Ohms law, then demonstrated the relationship of current and potential difference thereafter. On the other hand Clara started with demonstration to reach conclusion about the reaction of alkanes and alkenes that is addition and substitution reaction. Shranda's logical approach was inclined towards conducting practical work within the confines of the explanation model (Pekmez et al., 2005). According to Pekmez et al. (2005), the explanation model is merely used as the teaching

method to substantive understanding. Shranda's learners draw the graph from the results that were provided. Clara's learners have to complete a worksheet from their observation during demonstration. Clara conducted practical work within the confines of the performance model and explanation model (Pekmez, 2005). However, even though their logical structure is not the same, both teachers conducted closed practical work.

Another similarity to Shranda and Clara is the way both teachers identify the learning objective of practical work. It is clear that their understanding is that the purpose of the activity influences how practical work is conducted, contributing to the learning objectives of their practical work. Both teachers focused on the conceptual objectives of practical work. Kim and Chin (2011) is of the same view that science teachers tend to focus on concepts even in practical work rather than on the development of scientific knowledge. For example Shranda stated that by doing this activity, pupils should develop the knowledge of Ohms law and also recall a relationship between the current and potential difference. It is significant to note that teacher Shranda did not realise that another skill will be developed by learners during the lesson, that of drawing a graph of current versus potential difference. Other studies indicate that some learners have difficulty with graphical representation of measured data (Rens et al., 2011). Clara also stated the conceptual aim during the lesson that by doing this activity, pupils should develop the knowledge of different types of reactions (addition and substitution) and also differentiate between reaction undergone by alkanes and alkenes. It is clear that teacher Clara did not mention these observational skills. For learners to complete the worksheet they were required to observe the changes on the reaction and state those changes. This is the skill learners will acquire after practical activity.

The analysis on teacher understanding of practical work revealed that Shranda and Clara saw the value of practical work and that they included practical work in their lessons. Both teachers understand that practical work should be thought provoking for learners. Their actual practice was however contrary to their understanding of practical work. This practice is in contradiction to the coalition made by Tsai (cited by Kim & Tan, 2011) that science teachers' practices of

teaching are prominently derived from a congruency of their beliefs in teaching, learning and the nature of science. As far as Shranda and Clara are concerned, such is not the case. They used demonstration in their teaching in a way that was not thought provoking. Their understanding of practical work is learner-centred, but their practice is teacher-centred. Under these circumstances, one can note that both teachers' background indicated that they were trained in a traditional way, where emphasis was learner-centred, and they utilised a pedagogical style of rote learning. Against this background it can be seen that both teachers' pedagogical approach is inconsistent with their views of practical work. As suggested by Cheung (2007), one of the significant pedagogical problems faced in schools is that even excellent teachers with subject matter knowledge are not necessarily competent to teach inquiry-based practical work.

4.4.3 TEACHERS' UNDERSTANDING AND PRACTICE

It is evident from the data presented that Shranda and Clara have used only one type of practical work, that of demonstration. However, I mentioned that their logical approach to demonstration was not the same. This summary gives the teacher reflection on their practice.

4.4.3.1 Shranda's case

Shranda indicated the conceptual objective as the achieved outcome for the lesson. For her, learners were able to state the relationship between current and potential difference. Furthermore, Shranda stated that learners would draw the graph of current versus potential difference. She believed the objectives were achieved. Shranda justified this using demonstration as a method of doing practical work for the following reasons:

- Speed and ease of demonstration
- Demonstration yields correct results
- Time constraints
- Syllabus coverage
- Teaching the right concept

In addition, Shranda showed willingness to change demonstration as the way of conducting practical work to engaging learners to investigation.

4.4.3.2 Clara's case

Clara also indicated conceptual objective as the achieved outcome for the lesson. Even though Clara's learners used observation to complete the worksheet they were given, the stated objective was for learners to be able to differentiate between addition and substitution reactions. According to Clara lesson outcomes were achieved. Several factors contributed to Clara using demonstrations.

- Speed and ease of demonstration
- Large classes
- Lack of resources
- Time constraints
- Syllabus coverage

Furthermore, Clara made mention that for more dangerous investigations it would be best to use demonstration. In this case, Clara considered the safety of learners. Clara showed a willingness to change demonstration as the way of conducting practical work in order to engage learners in investigation. According to Clara, practical investigations are a curriculum requirement for Grade 11 learners.

4.4.3.4 Analysis of the two cases of teachers' understanding of practical work

Shranda and Clara responded positively to the question that asked if they linked the purpose of practical work to the type of practical work conducted, in this case demonstration. According to Gomes et al. (2008) the word, purpose refers to the pedagogic purpose established by the teacher, giving reasons why such activity is conducted. Furthermore, the aims or outcomes of the activity are specific content topics. In view of the above definition, Shranda and Clara gave similar statements for purpose and outcome of the practical work that they conducted. Both teachers indicated the conceptual purpose for conducting practical work which was the same as the intended learning outcome and those outcomes were achieved during the lesson. At the same time, both teachers stated that they made learners aware of the purpose of the activity.

Shranda and Clara justified the exclusive use of demonstration as practical work because there were difficulties that hampered the use of inquiry-based practical work. The difficulties of teaching inquiry-based practical work are certainly well documented in the literature (Kim& Tan, 2011; Kim & Chin, 2011; Hayward, 2003; Pillay, 2004). Both Shranda and Clara mentioned almost the same set of difficulties. These difficulties included limitation of resources, time constraints, large classes and the need for syllabus coverage. Shranda mentioned one difficulty that Clara did not mention. Shranda believed she should set practical work to teach the right concepts. According to Shranda, if practical work did not produce the expected results learners would question her content knowledge. Such an attitude, teaching the correct concept and being a good teacher is one of the difficulties to inquiry-based practical work according to Kim and Tan (2011). It is not surprising that both teachers used practical work to teach textbook knowledge, so it is important for them to get the correct answers that corresponds to those that can be found in the textbooks. This suggests that these difficulties shape both teachers pedagogical decision and action in conducting practical work. However, the literature also indicates that besides these difficulties, pedagogical knowledge challenges the minds of teachers (Kim & Tan, 2011; Rens et al., 2010).

In addition, when both teachers were asked about their willingness to change, they suggested changing from conducting demonstration to engaging learners in investigations. This suggestion indicated that both teachers appreciated that giving learners the opportunity to design and conduct their own investigation could increase learners' potential in doing science. The willingness of teachers to change to inquiry-based teaching is regarded as the component of PCK (Kask, 2009).

4.5 CONCLUSION

This chapter presented, analysed and discussed the findings that will be used to answer the research question. Using two different data-gathering strategies for the research, pre and post interviews and classroom observation, allowed for triangulation of the results. The data showed that both teachers understand the nature of practical work but due to contextual factors they are

unable to put it into practice. Classroom observation confirmed that Shranda and Clara used demonstration as type of practical work during their lesson. In the next Chapter, conclusions from the study, implications and recommendations are discussed.

CHAPTER 5

DISCUSSION AND CONCLUSION

5.1 Introduction

This chapter gives an overview of the research findings from a case study as well as the recommendations as informed by the findings from this study. The purpose of this study was to explore Grade 11 teachers' understanding of practical work and how this understanding of practical work influences their instructional practice. The main research question for this study was:

- *What are Grade 11 teachers' conceptions of practical work in Physical Sciences within the National Curriculum Statement (NCS) curriculum?*

The focus of this study was directed by the following sub-research questions:

- What are the Grade 11 Physical Sciences teachers understanding of practical work in Physical Sciences?
- How do Grade 11 Physical Sciences teachers use practical work to teach Physical Sciences?
- Why do Grade 11 Physical Sciences teachers use practical work in the teaching of Physical Sciences in the way that they do?

The conclusions of the findings in chapter 4 are further discussed below together with implications and recommendation.

5.2 Teachers' understanding about practical work

The pre-observation semi-structured interviews which elicited teachers' understanding of practical work revealed that the sampled Grade 11 teachers hold adequate understanding towards inquiry-based practical work. For both teachers, the definition of practical work includes hands-on activities that are performed inside the laboratory and which contribute to conceptual science knowledge. To both Shranda and Clara, practical work is a tool by means of which to teach scientific knowledge. However, for both teachers an understanding of practical work was limited to laboratory activities. The literature revealed that the use of practical work should not be limited to school laboratory (Millar, 2004). The NCS Physical Sciences policy document practical work has to be conducted using scientific inquiry, where learners conduct investigations (Department of Education, 2005). Furthermore these scientific investigations are not limited to the laboratory activities but extended to the surrounding environment like home or fieldwork. The NCS Physical Sciences policy document also suggested that the environment can be used as a tool to teach scientific investigations (Department of Education, 2005).

However, both teachers acknowledged and value the benefits of practical work and the discussion revealed that practical work must be used in the teaching of Physical Sciences. The teachers' view was similar to that of Millar (2004) when they stated that practical work is "essential and irreplaceable" in teaching and learning Physical Sciences. Nevertheless, for both teachers, the common purpose of practical work was to develop student interest and motivation, conceptual understanding and science process skills and techniques. The above views on the purposes of practical work are consistent with the views of science teachers from the study conducted by Pekmez (2005). The understanding of the types of practical work includes experiments, investigations, illustrations and demonstrations. Shrandas' response indicated that she knew about scientific investigation because it is one of the curriculum requirements for the programme of assessment. However, for both teachers, when stating the purpose of practical work, they did not include that practical work can be useful in developing inquiry skills of their learners. Both teachers agree on using demonstration as one type of practical work. The understanding of practical work alone as envisaged in the NCS policy documents is insufficient

for effective teaching of inquiry-based practical work. Teachers need to have PCK so as to improve teaching strategies and practical work usage in Physical Sciences.

5.3 Teachers' classroom practice

The analysis of classroom observation indicated that the sampled Grade 11 teachers understanding of practical work did not necessarily shape how they use practical work in their teaching. The teachers understanding of practical work and its purposes were conceived in a framework different from that in which they conducted the practical work. According to NCS Physical Sciences policy document, practical work has to be conducted within the framework of scientific inquiry. The teachers stressed the importance of hands-on activities for learners but this was not reflected by their practice. The findings revealed that both teachers used demonstration to teach Physical Sciences. This is consistent with the findings from other studies that science teachers within NCS continue to conduct demonstrations and offer 'cookbook-style' practical work (Pillay, 2004; Stoffel, 2005). Moreover, the demonstration that was used by teachers is classified by Rogan and Grayson (2003) in the profile of implementation as level 1, where the teachers use classroom demonstrations to help develop concepts.

The sampled Grade 11 teachers rarely used practical work to develop skills in planning scientific investigations. Both teachers' instructional practice was teacher-centred. This suggested that traditional teaching, which prioritises acquisition of knowledge over that of the acquisition of process skills, was preferred by both teachers. They used practical work to support the understanding of content by learners and to verify the principles of Physical Science. Practical work was seen as a means for supporting the development of substantive understanding (Pekmez et al., 2005). From classroom observation, both teachers were active and learner involvement was low. The use of practical work by both teachers revealed that understanding of the nature and purpose of practical work does not necessarily mean that teachers will use that understanding to teach Physical Sciences.

The classroom observation indicated that there is still a gap between classroom practice and the requirements of the NCS for Physical Sciences policy document, based on what teachers should do and what learners experienced. The LO1 for Physical Sciences focuses on investigation for the teaching of Physical Sciences. As mentioned in the second chapter, during investigation learners must make their own decisions using procedures such as planning, measuring, observing, analysing and evaluation (Department of Education, 2005). It can be deduced however that teachers continue to hold onto what is familiar to them namely, of being the designated imparter of knowledge. The conclusion that can be made from the sampled Grade 11 Physical Sciences teachers is that after the NCS implementation, these teachers continue to use non-inquiry-based practical work.

Learning Physical Sciences through inquiry requires of learners to be active and not solely rely on their teachers and become dependent on the textbooks. The role of the teacher during investigation requires the teacher to have the pedagogical knowledge to guide and support learners. However, the findings from international and South African schools studies reveals that teachers find it difficult to teach using inquiry- based practical work (Kim & Tan , 2011; Pillay, 2004; Stoffel, 2005). Although the NCS curriculum specifies that inquiry-based practical work must be carried out by learners, the research studies indicate that teachers strongly rely on demonstration and the use of worksheets when using practical work to teach Physical Sciences. Stoffel (2005) in his study indicates how a Physical Sciences teacher limits the contribution of learners towards practical work by instructing learners to take instruction from a worksheet to complete a practical activity. Pillay (2004) reveals that most teachers use demonstration as one type of practical work. From the findings of these studies, there is still a gap between policy and practice, between what is written in the NCS policy document, what teachers say they do, and what learners actually experience. The points formulated by Berg (2009) in chapter two, for evidence of PCK on effective instructional practice were not taken into consideration.

5.4 Reasons for teachers' classroom practice

The post-observation semi-structured interviews revealed that what teachers did in the classroom was not related to what they understood about practical work. Shranda and Clara's preference of cookbook activities and demonstration was associated with the challenges they were facing when implementing inquiry-based practical work. Both teachers mentioned contextual and content factors that influenced their practice and resorted in them using demonstrations in teaching Physical Sciences. Shranda and Clara indicated that they conducted demonstration because of time, wanting to satisfy the requirements of the programme of continuous assessment in Physical Sciences and teaching a large amount of content. This comment reveals that the teachers put more emphasis on content coverage or syllabus coverage than developing process skills for learners. Furthermore, Pillay (2004) indicates that science teachers prefer to teach content because it is examinable whereas there is no practical examination. On the other hand, both teachers in this study have large classes, which made them resort to conducting a demonstration. Kapenda et al. (2002), in their study conducted in Namibia, reveal that a large class is also the reason why science teachers resort to conducting non-inquiry based practical work. The contextual and content factors that influenced the use of practical work can be summarised as a limitation of resources, time constraints, large classes and syllabus coverage. However, both teachers showed a willingness to change from demonstration to teaching science through inquiry-based practical work.

On answering the main research question, the sampled Grade 11 Physical Sciences teachers showed adequate understanding about inquiry-based practical work, but their understanding did not shape how they conducted practical work. The sampled Grade 11 Physical Sciences teachers' instructional practice did not ensure that the tasks were learner-centred in order to develop problem-solving skills in learners (Department of Education, 2005). The sampled Grade 11 teachers displayed sufficient PCK when it came to knowledge of the curriculum requirements for inquiry-based practical work. However, the teachers displayed a poor account of PCK for effective laboratory teaching, which in this study is regarded as the knowledge base for teaching that utilises practical work. These findings revealed that the understanding that Grade 11

Physical Sciences teachers have of what inquiry-based practical work is and of its purposes did not ensure that they would conduct practical work according to that understanding.

The above findings bring some implication on the NCS curriculum implementation in Physical Sciences. Our findings highlight two important points: firstly that

- an intervention by the Department of Education to guide teachers towards inquiry approaches in practical work is important, and secondly, that
- teachers themselves have the challenge of accepting and practicing new inquiry approaches to practical work.

The NCS curriculum should be effectively implemented, however the Department of Education has not been able to ensure implementation of the knowledge and resources for inquiry-based practical work. Furthermore, the Department of Education has not made any documentation available to teachers such as teaching resources for inquiry-based practical work. Thus, Physical Sciences teachers rely on authentic resources for their classroom lessons and activities. Rogan and Grayson (2003) indicate in their study that some reasons for the failure of a well designed curriculum is lack of a clearly thought out implementation strategy. Stoffel (2005, p. 156) calls for an improvement in the quality of published texts and also for far-reaching teacher development initiative, he adds that this will “boost teachers’ confidence and competence to interpret, transpose and customise curriculum support text.” Moreover, teachers themselves must be willing to change to inquiry-based teaching. Kask (2009) regards ‘willingness to change’ as one component of PCK that is recognised as a crucial factor in promoting inquiry teaching.

5.5 Recommendations

The findings from sampled Grade 11 teachers regarding the use of practical work are inconsistent with the requirements of NCS. The understanding that teachers have about practical work does not ensure that they conduct practical work according to that understanding. From the findings and analysis of this study, I offer the following recommendations to improve teachers’ instructional practices of practical work within NCS.

Teachers need professional development through in-service training in order to implement inquiry-based practical work effectively in class. Therefore, the recommendation is that the Department of Education, working together with Subject Education Specialists (SES), continually develops teachers PCK through in-service training. Cheung (2007) suggests that interventions such as a three hour workshop will not have a long impact on classroom practice, but that professional development must be intense and sustained. Teachers are not lacking in the knowledge of what works or might not work in terms of science activities, what is lacking is teachers pedagogical knowledge. Even teachers with good subject knowledge find it difficult to guide learners through inquiry-based practical work (Kim & Chin, 2011). The teachers' strong PCK will help to reduce if not to solve some of the challenges facing the implementation of inquiry-based practical work.

The Department of Education, together with curriculum developers, needs to revisit the subject content (syllabus) for Grade 11 Physical Sciences. There is more content knowledge that needs to be taught in the subject for this grade. Accordingly teachers will inevitably put emphasis on teaching the content, and not to develop the process skills for learners. This shows that even within the NCS the LOs are not given equal importance. LO-2 for construction and applying scientific knowledge is given the top priority over LO-1 and LO-3. There is a need to restructure the scope of Physical Sciences as a subject in such a way that all LOs are apportioned enough teaching time.

The priority of LO-2 is emphasised even during examination. The NCS curriculum has shifted to OBE but the Department of Education and curriculum developers are still using the traditional paper and pen examination even to assess the performance of learners in LO-1. The Department of Education needs to develop a systematic method of assessing or evaluating the learners' performance in practical work.

Large classes seem to get in the way of teachers conducting inquiry-based practical work especially in black African schools (Pillay, 2004). It is recommended that the Department of Education design a strategy for calculating the post-provisional norm (PPN) for schools, especially for more demanding subjects like Physical Sciences. PPN is the ratio of a teacher to

learners. Moreover, the Department of Education could also look at providing schools that offer Physical Sciences as a subject with a laboratory assistant.

5.6 Conclusion

The assumption that a teachers' understanding of the nature and purpose of practical work might itself be a determining factor of instructional practice used by the teacher might not be true. This study has revealed that the sampled Grade 11 teachers had enough understanding about the nature and purpose of inquiry-based practical work but they nonetheless still used traditional approach due to certain limiting logistical factors. Teachers seem to be trying to adapt to the changes of the NCS, but they are doing that slowly. The NCS curriculum is not effectively implemented. It is therefore suggested that the Department of Education and curriculum developers must support Physical Sciences teachers in implementing the NCS curriculum. There ought to be an implementation strategy that accompanies curricular requirements for inquiry-based practical work.

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APPENDIX A1

PRE - OBSERVATION INTERVIEW SCHEDULE FOR PHYSICAL SCIENCES

TEACHERS

Research Questions	Interview Questions
<p>1. What are the Physical Sciences teachers understanding of practical work?</p>	<ul style="list-style-type: none">• Can you briefly explain what practical work means to you?• What kinds (types) of practical work do know?• From the kinds (types) that you have mentioned above, which ones do you use in your teaching of Grade 11 learners?• Why do you choose that particular kind (type) of practical work?• How frequently do you conduct practical work?• What would you say is the purpose of practical work in teaching and learning?• Do you link the purpose of practical work with the kind (type) of practical work that will be conducted during a lesson? If yes, how? If no, explain why not.

APPENDIX A2

POST - OBSERVATION INTERVIEW SCHEDULE FOR PHYSICAL SCIENCES

TEACHERS

Research Questions	Interview Questions
2. Why do teachers integrate practical work in the teaching of physical sciences in the way that they do?	<ul style="list-style-type: none">• What was the intended learning objective of the practical work that you conducted / engage learners in?• Were the objectives achieved? Explain.• Were learners aware of the purpose of the activity? Explain.• If you were to change the way you conducted practical work, what would you change?• Do you think that the conception/understanding you have about practical work has influence the way practical work was conducted during you lesson? Explain.

3. How do Physical Sciences teachers integrate practical work in the teaching of physical sciences?	<ul style="list-style-type: none">• How do you carry out these activities to achieve their aims (or how do you organise practical work to achieve its aim)?
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APPENDIX B

OBSERVATION SCHEDULE FOR PHYSICAL SCIENCES

SCHOOL: _____ TEACHER'S NAME: _____

DATE: _____ TOPIC: _____

DURATION OF LESSON: _____ VENUE: _____

NUMBER OF LEARNERS: _____ OBSERVATION NO.: _____

2.1 Identifying the learning objective of a practical work

Objective (in general terms)	Tick one box to indicate the 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 practical procedure		Students can use a piece of equipment, or follow a practical procedure, that they have not previously met	
		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		Students have a better general understanding of scientific enquiry	
		Students have a better understanding of	*

approach to enquiry		some specific aspects of scientific enquiry	
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*if you have ticked this box, please complete the table below

Specific aspects of scientific enquiry	Tick all that apply
How to identify a good investigation question	
How to plan a strategy for collecting data to address a question	
How to choose equipment for an investigation	
How to present data clearly	
How to analyse data to reveal or display patterns	
How to draw and present conclusions based on evidence	
How to assess how confident you can be that a conclusion is correct	

2. DESIGN

2.1 Openness/closure	Tick one box
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 one box
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:	
2.3 Importance of scientific ideas (to carry out the activity well) (Rate: 4= essential; 3=fairly; 2=not very; 1=unimportant)	
Importance of an understanding of scientific ideas	
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	

3. PRESENTATION

3.1 How is the purpose, or rationale, communicated to students?	Tick one box
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 before hand	
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 one box
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 C2:

LETTER TO THE GRADE 11 PHYSICAL SCIENCES TEACHER

P.O. Box 1269

Mtubatuba

3936

I am Sebenzile Helga Ngema, a Masters Student studying at the University of KwaZulu-Natal. In fulfillment of my degree I am required to conduct a research project in my field of interest. I have chosen the following topic for my field of research:

A case study exploring Grade 11 teachers' conception of practical work in Physical Sciences within the National Curriculum Statement (NCS) curriculum.

Using teachers as participants, this research aims to answer the following questions:

- What are the Grade 11 Physical Sciences teachers understanding of practical work in Physical Sciences?
- How do Grade 11 Physical Sciences teachers use practical work to teach Physical Sciences?
- Why do Grade 11 Physical Sciences teachers use practical work in the teaching of Physical Sciences in the way that they do?

The findings of this research will contribute to the knowledge of what are Physical Sciences teachers' conceptions about practical work. These findings will be of benefit to physical sciences Subject Education Specialists (SES) to use during intervention with teachers in their districts. It will also assist practicing Physical Sciences teachers on the type of practical work used in science teaching and how to integrate it in the teaching of Physical Sciences. It will be of benefit to the school and Department of Education.

Research Ethics:

(1) There will be no risks to the participants (harm).

(2) The principle of voluntary participation will be adhered to and the participants may withdraw from the study at any point.

(3) The respondents will be offered confidentiality and anonymity by signing a confidentiality contract. Each respondent will be given a pseudonym. The respondents will not be aware of the pseudonym and the code for the various respondents.

(4) The respondents will receive feedback on the research process. They will also be asked to respond to transcripts of interviews to verify and confirm the responses given during the interview.

(5) The research data will be used for the purposes of this research only.

Research Expectations of Respondents:

(1) The teacher participation will be for the duration of +/- 4 weeks.

(2) Each teacher will be expected to participate in two interviews and to teach two lessons for observation purposes. Teacher resources will be examined.

Thank you for your assistance. If you have any questions you may contact:

Researcher: Sebenzile Ngema (072 700 44 19)

Supervisor: Dr. Angela James (031-260 34 38)

Yours sincerely

S.H.Ngema

RESEARCH PROJECT TITLE:

An exploration of Grade 11 teachers' conception of practical work in Physical Sciences within the National Curriculum Statement (NCS) curriculum. .

CONSENT FORM FOR TEACHER

I have read the above and agree with the terms. I understand that my real name will not be used in any aspect of the write-up of the study and that the information will only be used for the purposes of this research project. 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.

I have given consent to my participation in this research.

Name: _____ Signature: _____

Date: _____

APPENDIX C3

**LETTER TO THE PRINCIPAL FOR PERMISSION TO CONDUCT RESEARCH AT
THE SCHOOL**

P.O. Box 1269

Mtubatuba

3936

Dear Sir /Madam,

I am Sebenzile Helga Ngema, a Masters Student studying at the University of KwaZulu-Natal. In fulfillment of my degree I am required to conduct a research project in my field of interest. I have chosen the following topic for my field of research:

A case study exploring Grade 11 teachers' conception of practical work in Physical Sciences within the National Curriculum Statement (NCS) curriculum.

Using teachers as participants, this research aims to answer the following questions:

- Using teachers as participants, this research aims to answer the following questions:
What are the Grade 11 Physical Sciences teachers understanding of practical work in Physical Sciences?
- How do Grade 11 Physical Sciences teachers use practical work to teach Physical Sciences?
- Why do Grade 11 Physical Sciences teachers use practical work in the teaching of Physical Sciences in the way that they do?

The findings of this research will contribute to the knowledge of what are Physical Sciences teachers' conceptions about practical work. These findings will be of benefit to physical sciences Subject Education Specialists (SES) to use during intervention with teachers in their districts. It will also assist practicing Physical Sciences teachers on the type of practical work used in science teaching and how to integrate it in the teaching of Physical Sciences. It will be of benefit to the school and Department of Education.

Research Ethics:

- (1) There will be no risks to the participants (harm).
- (2) The principle of voluntary participation will be adhered to and the participants may withdraw from the study at any point.
- (3) The respondents will be offered confidentiality and anonymity by signing a confidentiality contract. Each respondent will be given a pseudonym. The respondents will not be aware of the pseudonym and the code for the various respondents.
- (4) The respondents will receive feedback on the research process. They will also be asked to respond to transcripts of interviews to verify and confirm the responses given during the interview.
- (5) The research data will be used for the purposes of this research only.
- (6) The research will not impinge on the teaching time of the participants.

Research Expectations of Respondents:

- (1) The teacher participation will be for the duration of +/- 4 weeks.
- (2) Each teacher will be expected to participate in two interviews and to teach two lessons for observation purposes. Teacher resources will be examined.

Thank you for your assistance. If you have any questions you may contact:

Researcher: Sebenzile Ngema (072 700 44 19)

Supervisor: Dr. Angela James (031-260 34 38)

Yours sincerely

S.H.Ngema

RESEARCH PROJECT TITLE:

An exploration of Grade 11 teachers' conception of practical work in Physical Sciences within the National Curriculum Statement (NCS) curriculum. .

LETTER FOR SCHOOL (PRINCIPAL)

I have read the above and agree with the terms. I understand that the real name of the school will not be used in any aspect of the write-up of the study and that the information will only be used for the purposes of this research project. I am also aware that the research will not impinge on the teaching time of the participants.

I have given consent to my teachers to participate in this research.

Name: _____ Signature: _____

Date: _____

|

APPENDIX D: ETHICAL CLEARANCE CERTIFICATE



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Westville Campus
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11 July 2011

Mrs SH Ngema (981226240)
School of Science, Mathematics and
Technology Education
Faculty of Education
Edgewood Campus

Dear Mrs Ngema

PROTOCOL REFERENCE NUMBER: HSS/0474/011M

PROJECT TITLE: An exploration of Grade 11 teachers' conception of practical work in Physical Sciences within the National Curriculum Statement (NCS) curriculum

In response to your application dated 6 July 2011, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the school/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....
Professor Steven Collings (Chair)
HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE

cc. Supervisors: Dr A James & Mrs M Good
cc. Mr N Memela/Ms T Mnisi

APPENDIX E1 : PRE - INTERVIEW TRANSCRIPT FOR SHRANDA : 26 JULY 2011

Pre - interview transcript		
Research question	Interview questions	Line number
1. What are the Physical Sciences teachers understanding of practical work?	REA: Thank you very much madam for allowing me to come and interview you. I am going to ask you few questions on your knowledge of practical work and then on the practical work you have done. You may answer the questions to the best of your ability. There is no wrong or correct answer. If there is something you did not get right you are free to ask me and I will clarify it you. I am not going to take too much of you time. The first question is can you briefly explain what practical work means to you?	1 2 3 4 5 6 7 8 9
	Shranda: Practical work is the activity which is done by the teacher or by pupils themselves using apparatus to reinforce what they have learnt in class. It helps pupils to understand scientific ideas. During practical work pupils are engage in an experiment to prove a particular theory or law. Practical work is the activity that gives pupils a chance to act like scientist and be able to solve problems.	10 11 12 13 14 15 16
	REA: Do you think practical work is important for teaching and learning Physical Sciences? If yes, how? If no, explain why not.	17 18
	Shranda: Yes, I think practical work is important because it helps pupils to learn physical science or understand the subject better. Pupils understand some physical science concepts better when they see things happening. This means that practical work makes abstract ideas to be more real or concrete. It also makes pupils to love and enjoy physical science, for example in our school most pupils will choose physical science as a subject because they	19 20 21 22 23 24 25

<p>What are the Physical Sciences teachers understanding of practical work?</p>	want to do practical work. They want to go to the laboratory.	26
	REA: So do you mean practical work helps to reinforce physical sciences concepts?	27
	Shranda: YES	28
	REA: What would you say is the purpose of practical work in teaching and learning?	29
	Shranda: Uhm..., the purpose of practical work will be to expose pupils to a meaningful learning where they will observe what is happening during the experiment, collect apparatus and feel them. During practical work pupils will get a deeper understanding of the theory. Infact the purpose of, practical work is to involve pupils and to give them a chance to observe by themselves, encourage accurate observations collect, analyse data and reach conclusion. Practical work is supposed to enhance the scientific knowledge of pupils. The curriculum state that practical work should develop process skills in pupils.	30
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REA: What kinds or types of practical work do you know?	41	
Shranda: I am not sure but I will say experiments, demonstrations and err practical investigations which are required by the curriculum.	42	
REA: Do you think the different types of practical work that you mentioned, have different purposes? Explain your answer.	43	
Shranda: Yes they can have different purposes for example demonstrations cannot serve the purpose of developing pupils skill because pupils are not hands-on. I think practical investigation is the type of practical work that develops pupils' process skills.	44	
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REA: OK, from the kinds (types) that you have mentioned, which ones do you use in your teaching of Grade 11 learners?	46	
Shranda: Ooh... I usually used demonstrations when I am teaching. Demonstration helps me if I want to prove a particular	47	
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	concept for my pupils or verify particular concepts in the lesson.	57
	Sometimes I wish that my class to experiments and conduct investigations when learning physical science.	58 59
	REA: OK briefly describe how you use demonstration?	60
	Shranda: Firstly, I use to explain to them that I will do a demonstration when I introduced my lesson so that the pupils can concentrate carefully and make them aware that at the end of the demonstration they will be engaged in answering the questions or completing a worksheet. I will then demonstrate my lesson and after demonstration they will have to answer questions set for them or also they will be asked to complete the worksheet designed for that particular lesson. If the apparatus are small not visible to the whole class I divide them into groups and give them a designed a worksheet with instructions and steps by steps procedure to be followed and provide blank spaces where they will write their observations and conclusions.	61 62 63 64 65 66 67 68 69 70 71 72
	REA: How frequently do you conduct practical work?	73
	Shranda: I think..err...probably six, at least one per knowledge area. In Physical Sciences we have six knowledge areas. But the programme of assessment requires two practical investigations.	74 75 76
	Thank you.	77
	REA: Thank you	78

APPENDIX E2: POST -INTERVIEW TRANSCRIPT FOR SHRANDA:29 JULY 2011

Post - interview transcript		
Research question	Interview questions	Line number
Why do teachers use practical work in the teaching of Physical Sciences in the way that they do?	REA: Thank you for allowing me to be part of your lesson. I wish to ask you few questions based on this lesson Why did you use practical work in your lesson?	79 80 81
	Shranda: In this lesson I wanted my pupils to understand and be able to state Ohms law. I gave them an opportunity to observe the relationship between the current and potential difference, represent the collected data on the graph and interpret the graph to reach conclusion.	82 83 84 85 86
	REA: Did you link the purpose of practical work with the kind (type) of practical work that was conducted during a lesson? If yes, how and If no, explain why not.	87 88 89
	Shranda: Hhmm..I will say yes because I have used demonstration to help pupils know about the relationship between current and potential difference that is Ohms law. The whole class recorded the readings and was able to draw the graphs.	90 91 92 93 94
	REA: What were the intended learning outcomes of the practical work that you conducted OR engage learners in?	95 96
	Shranda: According to the lesson plan, at the end of the lesson pupils should be able use graph to show the relationship the current in and the potential difference and also be able to state the Ohms law.	97 98 99 100
	REA: Were the learning outcomes achieved? Explain.	101
	Shranda: Oh yes, I think the objectives were achieved because learners were able to draw a straight line graph which implies	102 103

	that increasing the potential difference results in an increase in	104
	current and they were able to interpret and draw the conclusion	105
	from the graph they have drawn.	106
	REA: Mam were learners aware of the purpose of the activity?	107
	Explain.	108
	Shranda: Yes, they were aware because when I introduced my	109
	lesson, I did mention that I will be doing the demonstration on	110
	the relationship between the current and the potential difference	111
	and I want them to record the ammeter and voltmeter readings so	112
	that they will draw a graph	113
	REA: Why did you choose this particular kind of practical work,	114
	meaning demonstration as one type of practical work to use	115
	during the lesson?	116
	Shranda: It is easy to demonstrate because I don't waste time. I	117
	demonstrated Ohms law over a single period. I tried to do the	118
	demonstration correctly so that I get the correct results to verify	119
	what we were learning about in this case Ohms law. I do it	120
	myself because sometimes pupils can not even take a reading on	121
	the ammeter and voltmeter. My objective when doing	122
	demonstration was for my pupils to make observations so that	123
	they can see relationships between the current and potential	124
	difference. In other words, I did demonstration to help my pupils	125
	understand this particular scientific concepts or law. Another	126
	reason I chose to do demonstration is that investigations are time	127
	consuming because when pupils do their own experiments they	128
	sometimes do not get desired or correct results so they keep on	129
	trying. Some investigations cannot be done over a single period	130
	and the Grade 11 curriculum is too long to waste time doing	131
	investigation. I have a pressure to cover the content and prepare	132
	learners for exam. You know mam pupils make lots of mistakes	133
	when working in groups doing experiments. It is difficult to	134

	explain to them why they don't get correct results. And pupils	135
	will think I don't know physical science if I don't give them	136
	answers.	137
	REA: Why do you think pupils make mistakes when doing	138
	experiments?	139
	Shranda: ahh..... I think they lack the background on	140
	conducting experiments; they do not know most of scientific	141
	procedures. I don't have time to go back and teach them things	142
	that they are suppose to know and I have pressure of work as	143
	well.	144
	REA: What enables OR constrains the implementation of	145
	practical work in you lesson?	146
	Shranda: The practical work went well, I managed to complete it	147
	during the allocated time frame and pupils were able to observe	148
	the relationship. Constrains are that the class is overcrowded so I	149
	can not involve all pupils. Some pupils seem not interested to	150
	observe some cannot see in the demonstration table. I cannot	151
	repeat the demonstration because of the time factor.	152
	REA: If you were to change the way you conducted practical	153
	work, what would you change? And why?	154
	Shranda: I will change the type of practical work from	155
	demonstration to investigation. I will allow pupils to do the	156
	practical work for themselves. It is good for pupils to discover	157
	things for themselves while engaging in hands-on activities.	158
	When pupils discover things for themselves they do not forget	159
	easily. My work as the teacher will be to design practical work in	160
	a way that encourages pupils to discover for themselves. The	161
	Physical Sciences documents encourage pupils to conduct	162
	investigations so that they can develop interpretive and process	163
	skills. But under circumstances I am forced to do demonstration	164
	because there are not enough laboratory equipments. We do have	165

	the laboratory but it lack resources.	166
	REA: Thank you	167

APPENDIX E3: PRE - INTERVIEW TRANSCRIPT FOR CLARA : 15 AUGUST 2011

Pre - interview transcript		
Research question	Interview questions	Line number
1. What are the Physical Sciences teachers understanding of practical work?	REA: Thank you very much madam for allowing me to interview you. I am going to ask you few questions on your knowledge of practical work and then on the practical work you have done. You may answer the questions to the best of your ability. There is no wrong or correct answer. If there is something you did not get right you are free to ask me and I will clarify it you. I am not going to take too much of you time. The first question is can you briefly explain what practical work means to you?	1 2 3 4 5 6 7 8 9
	Clara: hhm..thank you mam according to my understanding practical work is a hands-on activity or you can say that is something that learners do using the apparatus.	10 11 12
	REA: What do you mean by hands-on	13
	Clara: by hands-on I mean that is where pupils they handle the apparatus and manipulate them and after doing the experiment is where they can may be draw conclusions.	14 15 16
	REA: Mam do you think practical work is important for teaching and learning Physical Sciences? If yes, how? If no, explain why not.	17 18 19
	Clara: I think practical work is important when I teach physical science because it makes the concepts to be more real not abstract when pupils are hands-on doing experiments. Let us say for example like our Grade 11 we have the concept like titration in acid and base it become difficult to teach that concept to learners so the best thing is to do the experiment with learners	20 21 22 23 24 25

<p>What are the Physical Sciences teachers understanding of practical work?</p>	<p>where they will be observing during the titration where may be there is a colour change and they will looking at the reaction and they will be observing the end point. There are some experiment like Boyles law. When you want to explain and emphasise may be to allow learners to draw some graph you cant just teach them you make them to do the practical and take some readings so that they can make their conclusions and draw the graphs.</p> <p>REA: OK, madam what would you say is the purpose of practical work in teaching and learning?</p> <p>Clara: hhm...Practical work it helped teachers and learners. It helped teachers to make it clear on what they are teaching and it contributes to learners the understanding of the content. It makes learners to be able to do practical work, to do the measurements and to enjoy to be in the lab to see themselves as scientists. And it also helps them to be able to interpret what they have observed during the experiment and after that to draw some conclusions.</p> <p>REA:OK mam, what kinds of practical work do you know?</p> <p>Clara: There are different types of practical work that I know the first one like investigations err...and there is another one which is called illustrations and demonstrations.</p> <p>REA: Yes, do you think the different types of practical work that you mentioned, have different purposes? Explain your answer.</p> <p>Clara: Yes mam different practical work has different purposes. For example practical investigation or experiments can be used to develop practical skills like accurate measurement and to allow learners to be able record what they have seen during the experiment. When it comes to demonstration that one cannot develop practical skills because it is used by a teacher so the learner when they use the practical investigation they have the hands-on</p>	<p>26</p> <p>27</p> <p>28</p> <p>29</p> <p>30</p> <p>31</p> <p>32</p> <p>33</p> <p>34</p> <p>35</p> <p>36</p> <p>37</p> <p>38</p> <p>39</p> <p>40</p> <p>41</p> <p>42</p> <p>43</p> <p>44</p> <p>45</p> <p>46</p> <p>47</p> <p>48</p> <p>49</p> <p>50</p> <p>51</p> <p>52</p> <p>53</p> <p>54</p> <p>55</p> <p>56</p>
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	REA: From the types that you have mentioned, which ones do you use in your teaching of Grade 11 learners?	57 58
	Clara: Hmm...in most of the cases I use to demonstrate because we have the shortage of apparatus and the classes are overcrowded so its easy for me to use demonstration.	59 60 61
	REA: OK can you briefly describe how you use demonstration?	62
	Clara: I used demonstration in different ways. Sometimes I teach a concept and then demonstrate to my pupils what I was talking about. It makes it to be easy because my class now knows the theory part. For example I will explain redox reactions and then do a demonstration of copper sulphate solution with zinc granules. Other days I design a worksheet with leading questions and spaces to write answers. I will ask my pupils to observe the demonstration and complete the worksheet.	63 64 65 66 67 68 69 70
	REA: Thank you mam, how frequently do you conduct practical work?	71 72
	Clara:Hmm I do practical work but in most of the time I use demonstrations because they are saving me time and demonstration is easy to make since I mentioned that my classes are to big so I use to do demonstration to make my life easy.	73 74 75 76
	REA: Thank you	77

APPENDIX : E4 -POST - INTERVIEW TRANSCRIPT FOR CLARA: 18 AUGUST 2011

Post - interview transcript		
Research question	Interview questions	Line number
Why do teachers use practical work in the teaching of Physical Sciences in the way that they do?	REA: Thank you for allowing me to be part of your lesson. I wish to ask you few questions based on this lesson. The first question is why did you use practical work in your lesson?	78 79 80
	Clara: I used practical work when I was explaining reactions. It will not be easy for pupils to understand the difference between addition and substitution reactions. Practical work was important to demonstrate that alkanes have slow reactions than alkenes. The purpose of the practical activity in this lesson was for pupils to be able to differentiate between substitution and addition reactions.	81 82 83 84 85 86 87
	REA: Mam, what were the intended learning outcomes of the practical work that you conducted OR engage learners in?	88 89
	Clara: The purpose of the practical activity in this lesson was for pupils to be able to differentiate between substitution and addition reactions. Mam you saw I use cyclohexane and cyclohexene and bromine water.	90 91 92 93
	REA: OK, did you link the purpose of practical work with the kind (type) of practical work that was conducted during a lesson? If yes, how and If no, explain why not.	94 95 96
	Clara: Mam you were there you see that after demonstration the class observes that cyclohexane has a slow reaction with bromine water as compared to cyclohexene. So the purpose of practical work was achieved through demonstration. I can say yes to your question.	97 98 99 100 101
	REA: Were the learning outcomes achieved? Explain.	102

Clara: Yes alkanes undergo substitution reaction while alkanes undergo addition reaction.	103 104
REA: Were learners aware of the purpose of the activity? Explain.	105 106
Clara: Yes, pupils were aware. I introduced the lesson by asking some few questions from the previous work from what they already know about hydrocarbons and then I told them about the demonstration and what I want them to observe. The purpose of the activity was clarified to learners.	107 108 109 110 111
REA: OK mam why did you choose this particular kind of practical work, meaning demonstration as one type of practical work to use during the lesson?	112 113 114
Clara: Hmmm ... I chose it because demonstration is easy to make since I have big classes and I have the shortage of apparatus to make each of my learners to have a hands-on experiment. Even if I had apparatus it will be difficult to control each pupil or groups of three pupils due to big numbers. And the other thing that I can say is that is time consuming. Pupils do not finish the experiment during one period they will need more time may be two to three periods to finish this experiment. You know mam the syllabus for Grade 11 is too long so I can't risk time I must conserve time.	115 116 117 118 119 120 121 122 123 124
REA: OK mam, what enables OR constrains the implementation of practical work in you lesson?	125 126
Clara: It was an easy demonstration. The demonstration was not dangerous like reaction of sodium with water so it easy to demonstrate. I managed to finish it fast and I had class discussion and allow the class to finish the worksheet that I already prepared for them. And there no constrains with this experiment as you were there you saw everything. There was a lot of class discussion that took place.	127 128 129 130 131 132 133

	REA: If you were to change the way you conducted practical work, what would you change? And why?	134 135
	Clara: The experiment is easy and not dangerous. It will be good for pupils to be hands-on, so that they can touch apparatus like test tubes, and be able to improve their measuring skills and to take some volume equal volumes of cyclohexane and cyclohexane. but it was a good experiment.	136 137 138 139 140
	REA: Why it is good to be hands-on for learners	141
	Clara: it is good because some pupils can develop process skills of measuring and observing which is encouraged to pupils who are doing physical science. When pupils are hands-on they feel like real scientists. Another reason they will be conducting their own investigation. It is a requirement for Grade 11 assessments for learners to conduct investigations. So I think it is helping them to do the practical work.	142 143 144 145 146 147 148
	REA: Thank you.	150

APPENDIX F1

OBSERVATION NOTES FOR SHRANDA'S CLASSROOM PRACTICE ON THE 28TH

JULY 11

OBSERVATION	SHRANDA
Identifying the learning objectives of the practical work	-By doing this activity, pupils should develop the knowledge of Ohms law -Pupils can recall a relationship between the current in a resistor and potential difference across it.
Design of practical activities, looking at the degree of openness	-The teacher uses demonstration to help develop the concept of Ohms law - Learners observe a closed practical work
Logical structure	-The teacher begin with definition of the law (Ohms law) -The Teacher collected data and learners tabulate results on their exercise books
What learners has to do with objects or material in a practical activity	- Learners observe and copied the values of current and potential difference in the table form and then draw the graphs -Practical work used to verify the law
What learners has to do with ideas in a practical activity	- Identify the relationship between current and potential difference -Draw the graph of current versus potential difference.
How is the purpose / rationale, communicated to learners	-Activity is proposed by the teacher -Purpose of the activity explained by the teacher
How is the activity explained to learners	-Orally by the teacher -Activity demonstrated by the teacher
Whole class discussion before the practical activity begins.	-About the concepts, equipments and procedure during demonstration
Whole class discussion following the practical activity.	-Centred around a demonstration in which the teacher performed linking it to the concept of Ohms law

Learners record of the activity	-Drawing the graphs with a given structure and format
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APPENDIX F2

OBSERVATION NOTES FOR CLARA'S PRACTICE ON PRACTICAL WORK ON 17

AUGUST 2011

OBSERVATION	TEACHER CLARA
Identifying the learning objectives of the practical work	-By doing this activity, pupils should develop the knowledge of different types of reactions (addition and substitution) -Pupils can differentiate between reaction undergone by alkanes and alkenes.
Design of practical activities, looking at the degree of openness	-The teacher uses demonstration to help develop the concept of addition and substitution reaction - Learners observe a closed practical work
Logical structure	-The teacher begin with demonstration and learners observing -Learners collected data through completing the worksheet
What learners has to do with objects or material in a practical activity	- Some learners assisted the teacher during demonstration Learners observe and complete worksheet
What learners has to do with ideas in a practical activity	-Identify the differences between the alkanes and alkenes -Explain the difference between addition and substitution reaction undergone by alkanes and alkenes.
How is the purpose / rationale, communicated to learners	-Activity is proposed by the teacher -Purpose of the activity explained by the teacher
How is the activity explained to learners	-Orally by the teacher -Activity demonstrated by the teacher
Whole class discussion before the practical activity begins.	-About the concepts, equipments and procure during Demonstration
Whole class discussion following the practical activity.	-Centred around a demonstration - Discussion addition and substitution reaction of alkanes and alkenes
Learners record of the activity	-A completed worksheet