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AN INVESTIGATION INTO HOW A GRADE 10 TEACHER CONDUCTS PRACTICAL WORK IN THE CONTEXT OF THE NATIONAL CURRICULUM STATEMENT

A

RESEARCH REPORT

Submitted by

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Abstract

The study investigated how two grade 10 physical science teachers conducted practical work within the context of the National Curriculum Statement (NCS). The following research questions guided the study:

1. What are the grade 10 teachers' ideas of the nature of practical work?
2. What are the grade 10 teachers' ideas of the purpose of practical work?
3. How do the grade 10 teachers' ideas of the nature of practical work and its purpose shape how they conduct practical work?

Models used by Pekmez *et al.* (2005) for analysis and explanation of the thinking of teachers about practical work were used to frame the study. The case methodology was adopted for the study. Interviews and official documents in the form of laboratory reports and instruction sheets were used as the sources of data. Research questions, common sense, personal experience, literature reviewed and the theoretical and conceptual framework of the study were used to formulate initial categories to guide data analysis.

The study showed that teacher M had ideas of the nature and purpose of practical work within the framework of the investigation movement. Teacher B had ideas of the nature and purpose of practical work within the process and investigation movements respectively. However both teachers conducted practical work tasks within the explanation model. Hence teachers' ideas of practical work do not necessarily shape how they conduct it. Possible reasons for the teachers conducting practical work tasks within the framework different from that of their ideas are discussed. The implications of the findings for the NCS are discussed based on Rogan and Grayson's (2003) theoretical model of implementation. Current methods of disseminating information on how to conduct practical work are questioned. More discussions on how to design and conduct practical work are recommended.

Declaration

I declare that apart from the assistance acknowledged, this research report, titled

AN INVESTIGATION INTO HOW A GRADE 10 TEACHER CONDUCTS PRACTICAL WORK IN THE CONTEXT OF THE NATIONAL CURRICULUM STATEMENT

is my own unaided work. All sources that I have used or quoted have been acknowledged by means of complete citation and referencing. This research report is being submitted in partial fulfillment of the requirements for the degree Master of Science in science education at the University of the Witwatersrand Johannesburg. It has not been previously submitted for any degree or examination at any other university.

Mudau Awelani Victor

November 2007

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Glossary of acronyms

1. NCS – National Curriculum Statement
2. GDE – Gauteng Department of Education documents
3. LO1 – Learning outcome number 1
4. LSM – Learner support material
5. ASs – Assessment standards
6. STD – Secondary teachers diploma
7. CASS – Continuous assessment

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Chapter 1: Introduction

1.1 Background to the study

The change of the curriculum in South Africa implemented in Grade 10 in 2006 has brought with it the reinforced emphasis on practical work. Department of Education documents (2003 and 2005) define physical science subject as the subject that focuses on investigating phenomenon through scientific inquiry. According to Martin-Hansen (2003) even though scientific inquiry can be defined from different points of view, authentic scientific inquiry is student centered and students have to conduct investigations or experiments. The scientific inquiry method is that on which practical work is embedded (Ottander and Grelsson, 2006 and Stoffels, 2005). Learning outcome 1 (LO1) in the physical science National Curriculum Statement (NCS) is concerned with "practical scientific inquiry and problem solving skills" (Department of Education document, 2005:15). Hence it is the intention of the NCS that science should also be learnt through practical work. Department of Education documents (2005 and 2007) suggest that practical work can be assessed daily. To reinforce the stance of the NCS on the importance of practical work, it is suggested as a requirement that a practical investigation in the first two terms of the school calendar should form part of the assessment tasks that should be used to generate a term mark. At my school at the end of 2006 laboratory equipment was delivered from the Gauteng Department of Education documents (GDE). This also indicates that even the Provincial Department of Education documents holds practical work in high regard.

So much has been written about practical work, of which amongst other perspectives it was the lack of meaningful practical work done by teachers (Stoffels, 2005; Hodson, 1990; Perkins-Gough, 2007). My concern is whether the teachers are doing meaningful practical work in their classrooms looking specifically at the effort put forward by the Gauteng Department of Education documents (GDE). NCS implementation workshops were conducted in 2005 and 2006 by the higher education institutions and districts subject facilitators. At the workshop I attended, the presenters also addressed the issue of

how practical work can be done. However in this study I will not be investigating the impact of the training per se.

1.2 Rationale for the study

The study by Stoffels (2005) on how and why teachers use learner support material (LSM) to shape practical work, showed that even if teachers have all the resources, how they do practical work is influenced by a number of factors like in this instance LSM in the form of a textbook. A study by Ottander and Grelsson (2006) showed that even though teachers stressed that laboratory work is important, their objectives were not to enhance scientific inquiry, because they did not regard inquiry as important. Hence how they do practical work was influenced by their objectives and views on practical work.

A study by Hodson (1990) indicates that too much importance is placed on practical work. Teachers on the other hand are not achieving what they are intending to, due to how they conduct practical work in their classrooms. Perkins-Gough (2007) also indicates that teachers emphasise procedures in the laboratory than the outcomes. Hence the studies are emphasising that teacher practice can have an impact on how they conduct their practical work. However even though the studies touched on teacher practice their emphasis was on the importance of laboratory work and how that is not being achieved.

Bennett (2003) indicates that teachers' views of practical work may or may not reflect their actual classroom practice. Hodson (1990:33) also indicates that much of the practical work at schools is "ill-conceived, confused and unproductive and providing little educational value". Hence the need to look at teachers' views explicitly and how they relate to their actual practice.

1.3 Aim of the study

The aim of the study was to investigate how teachers' views of practical work shape how they conduct it.

1.4 Research problem and questions

Based on the responses and comments from the teachers during training and cluster meetings in the Johannesburg districts in Gauteng, more practical work is being attempted than previously thought. However the comments were inundated with doubts on the adherence to the NCS of how practical work should be conducted. Rogan and Grayson (2003:1172) 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". Hence ideas and implementation are interrelated and can be a cause for concern about teacher practice. A study by Stoffels (2005) showed that many factors like the LSM influence how teachers conduct practical work. Hence I became interested in investigating how a grade 10 teacher's views of practical work shape how he/she conducts it in the context of the NCS. The following research questions guided the study:

1. What are the grade 10 teachers' ideas of the nature of practical work?
2. What are the grade 10 teachers' ideas of the purpose of practical work?
3. How do the grade 10 teachers' ideas of the nature of practical work and its purpose shape how they conduct practical work?

1.5 Context of the study

Teachers teaching grade 10 physical science were used for the study. The teachers were teaching at the district 9 schools in Gauteng province. Official documents (practical work task reports and instruction sheets) were collected from the two teachers and interviews conducted between July and September 2007.

1.6 Delimitation of the study

The study focused on two teachers teaching grade 10 physical science. Two practical work tasks per teacher conducted in 2007 were used for data analysis. The rationale being that the study had to be done within a limited time and personal experience and that of colleagues shows that teachers do not do practical work every day. The every day information used for the research was collected only for the practical work tasks and the

interviews with the two teachers. The study was conducted in Gauteng province schools in district 9. This was for convenience purpose. The research investigated how the grade 10 physical science teacher's ideas of the nature of practical work and its purpose shape how the teacher conducts practical work within the context of the NCS.

1.7 Importance of the study

This is not a new study in the field of practical work, but it should shed some light into how teacher's views of practical work shape how the teacher conducts practical work within the context of the NCS. The results of the study could enable the curriculum designers to have an overview of what to do in helping teachers to do practical work meaningfully. This could also help teachers themselves to learn how other teachers' views on practical work shape their practice.

In the next chapter the literature reviewed for the study will be presented as well as the theoretical and conceptual framework.

Chapter 2: Literature Review

In making sense of the views of teachers on practical work, I reviewed the literature defining practical work, types of practical work, purpose of practical work, and historical perspectives on practical work. The Department of Education documents policy documents and guidelines were also reviewed to understand practical work in the context of the NCS. An empirical study on practical work conducted within the context of the NCS is also discussed.

2.1 Policy and guidelines

According to Department of Education document (2003: 9) "the subject physical science focuses on investigating physical and chemical phenomena through scientific inquiry". It also indicated that this is achieved by developing competences in three focus areas, of which one of them is developing " scientific inquiry and problem solving in a variety of scientific, technological, socio-economic and environmental contexts" (p.10). These focus areas form the basis of the three learning outcomes (LOs). Hence the above focus area becomes LO1 wherein learners are expected to develop scientific inquiry and problem solving skills. The inquiry skills amongst others include classifying, communicating, designing an investigation, comprehending, drawing and evaluating conclusions, observing, interpreting and predicting (Department of Education document, 2005). The learning outcomes are achieved through assessment standards (ASs) which are performance indicators. There are four assessment standards for LO1, of which the first one indicates that learners in grade 10 should be able to conduct an investigation and this should be evident when learners "plan and conduct a scientific investigation" (p.18). Hence practical work is fundamental in achieving LO1. Department of Education documents (2003, 2005 and 2007) refer to practical work as scientific investigation, experiments and practical investigations. On analysing the policy and guidelines the names refer to the same aspect which is practical work.

Practical investigations and experiments are also some of the assessment tasks that are used in the programme of assessment in physical science (Department of Education

documents, 2005 and 2007). Department of Education document (2005: 11) also indicates that ways of achieving the outcomes are spelt out through the ASs and this "cannot be attained in a vacuum but through content and context". Hence in achieving LO1, content is the vehicle.

It could be seen that the policy and guidelines of the Department of Education documents are such that practical work is fundamental in the teaching and learning of physical science. The ideas in the policy are visionary and educationally sound as purported by Rogan and Grayson (2003). However is the policy being put into practice?

2.2 What is practical work?

Is practical work laboratory work, practical experiment or investigation? It is impetrative in the context of this study to define practical work and indicate the different names that can be attached to it. According to Tsai (2003: 847) "practical work in school science means laboratory-based experience". Other authors (Ottander and Grelsson, 2006, White, 1996, Kask and Rannikmäe, 2006, Donnelly, 1998 and Stoffels, 2005) also share the same notion and see practical work as hands-on or minds-on practical learning opportunities. Department of Education documents (2003, 2005, and 2007) also hold the same notion. Hence practical work is laboratory work or hands-on or minds-on practical or laboratory based experience.

According to Stoffels (2005) practical work refers to those teaching and learning situations that offer learners opportunities to practice the process of investigation. He further indicates that "this would involve hands-on or minds-on practical learning opportunities where learners practice and develop various process skills" (p.148). The process skills referred to are amongst others: questioning, observation, hypothesising, predicting and collection, recording, analysis and interpretation of data. The process skills indicated by Stoffels (2005) are similar to the ones referred to in the ASs of LO1 for physical science in the NCS. In addition to process skills indicated by Stoffels (2005), the NCS indicates that students should be able to communicate and present their findings. It is also indicated by Department of Education documents (2005 and 2007) that practical

investigations and experiments should be focused on the practical aspects and process skills which are required for scientific inquiry. Kask and Rannikmäe (2006: 6) indicate that "inquiry based experimental work develops students' process skills". This notion is also held by Ottander and Grelsson (2006) and White (1996). It follows then that practical work that is based on scientific inquiry is a means of developing process skills.

Hence from the above ideas it appears that practical work is a way of teaching and learning that gives learners an opportunity to practice and develop process skills.

Millar *et al.* (1999) define practical work more broadly as a teaching and learning tool wherein students handle objects or materials they are studying. This idea is broad because it does not offer a hint as to what specifically can be called practical work. Hence no parameters can be used to say this is what can be practical work or not. Anything that learners are studying and they can observe or lay their hands on can be called practical work according to this definition.

According to Donnelly (1998: 588) "practical work usually means individual or small-group pupil laboratory work. It does not commonly refer to teacher demonstration". I agree with the notion that it does not refer to teacher demonstration and this is consistent with the NCS.

According to Pekmez *et al*. (2005) practical work can be defined from the perspective of the movements influencing it. The discovery learning movement depicts practical work as the means for discovery learning wherein learners develop their thinking. The process approach movement depicts practical work as the methodology that will give opportunities to learners to practice what scientists do when they are acting as a scientist. From this perspective practical work is not directed by the content. From the investigation movement practical work is seen in a more holistic approach. In this idea "learners have to be thinking about what lies behind what they are doing rather than simply applying a practiced process" (Pekmez *et al*. 2005: 11). Gott and Duggan in Pekmez *et al*. (2005) call the ideas which make the thinking behind the doing of science,

concepts evidence. Concepts evidence represents procedural understanding operating alongside substantive understanding. Procedural understanding concerns process skills and substantive understanding refers to the understanding of concepts laws and theories (Pekmez *et al*., 2005).

From the above ideas it is worth noting that there is a similarity between the process approach movement and the investigation movement on what practical work is. The process approach movement is concerned with the doing of science whilst the investigation movement moves a step further by being concerned with the thinking behind the doing 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). This approach is two-fold in that it caters for the content learners' need to understand as well as the process skills they have to practice and develop with the ultimate aim of developing problem solving skills.

According to Department of Education document (2007: 10) "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". Hence within the context of the NCS practical work can be defined from the investigation movement perspectives. It caters for the development of procedural understanding as well as substantive understanding with the goal of developing problem solving skills.

2.3 Purpose of practical work

The purpose in this context refers to the intentions of doing practical work. Kask and Rannikmäe (2006) indicate that the purpose of practical work is to enable students to acquire and practice process skills. The same notion is also reported by Perkins-Gough (2007), Department of Education documents (2005, 2007), Pekmez *et al*. (2005), Ottander and Grelsson (2006), Kapenda *et al*. (2002), Gott and Duggan (1996) and Hodson (1990). Hence practical work can be offered with the purpose of developing and giving students an opportunity to practice process skills.

Practical work can also be offered with the purpose of "enhancing the mastery of subject matter" (Perkins-Gough, 2007: 93). This view is also reported in the Department of Education documents (2005, 2007), Kask *et al.* (2006) Pekmez *et al*. (2005), Ottander and Grelsson (2006), Kapenda *et al*. (2002), Gott and Duggan (1996) and Hodson (1990). Hence practical work can be prepared with the purpose of enhancing the learning of scientific knowledge (Hodson, 1990) or what Gott and Duggan (1996) call substantive understanding.

It is also reported by Perkins-Gough (2007), Pekmez *et al*. (2005) Ottander and Grelsson (2006), Kask and Rannikmäe (2006) and Gott and Duggan (1996) that the purpose of practical work could be to cultivate interest and enjoyment in science and science learning. Perkins-Gough (2007) also indicates that practical work can be intended for the development of teamwork abilities. The development of problem solving skills is also the purpose of practical work (Pekmez *et al*. 2006 and the Department of Education documents (2003, 2005, and 2007).

From the above discussion there is little doubt that practical work has a purpose in the teaching and learning of physical science. However within the context of the NCS, even though there are various purposes of practical work, the overarching purpose of practical work is to develop process skills and substantive understanding with the ultimate goal of developing problem solving skills. This is based on the explanation of practical work in the Department of Education documents policy and guidelines. Practical work is also used for summative assessment as suggested by Department of Education documents (2005, 2007).

2.4 Types of Practical Work

Pekmez *et al.* (2005: 6) identified and described the following types of practical work for physical science;

1. Demonstrations that verify facts and principles.
2. Repetition by pupils of standard qualitative experiments, e.g., 'to show that…'

3. Repetition by pupils of standard quantitative experiments, e.g., measurement of physical constants
4. Fundamental classical experiments repeated to show crucial stages in the logical development of a principle or topic
5. Problem-solving or discovery experiments (by teacher or pupil) designed to answer a question raised in the development of the theoretical work
6. Investigation projects- problems worked out by the pupil(s); not necessarily connected in direct way with theoretical course
7. Practical work set primarily to develop skills in techniques

Pekmez *et al.* (2005) also indicate that the first three types of practical work were most frequently done by teachers. The investigation projects were rarely or never done.

Brown (1995), in Kapenda *et al*. (2002:54) identifies five types of practical work which are
1. Exercises to develop specific skills
2. Investigations including hypothesis testing or problem solving
3. Experiments to introduce students to particular phenomena
4. Demonstrations to allow the teacher to develop a scientific argument or create a dramatic impression
5. Fieldwork

Kask and Rannikmäe (2006) also indicate that there are cookbook recipe experiments that do not develop planning skills. Gott and Duggan cited in Bennett (2003: 95), classified different types of practical work into the following categories: practical work which develops *skills*, practical work for *observations*, practical work for *enquiry* of scientific concepts, laws and principles and practical work for *illustration* or verifying particular concepts. These categories encompass various types of practical work.

Hence it will be interesting in this study to also find the link between the type of practical work the teacher used and the purpose. Bennett (2003) indicates that there should be a link between the type of practical work the teacher used and the purpose.

2.5 Historical perspective

It is necessary to take a view at some of the historical perspectives on practical work. According to Hodson (1990), since 1882 science instruction was expected to be given through experiments by the Education Departments (in the UK, Australia and New Zealand). However he infers that they had demonstration in mind. He also indicates that practical work was regarded as an enjoyable form of learning in the 60s and 70s even though sometimes it was regarded as a waste of time. He further indicates that "teachers use practical work unthinkingly" (Hodson, 1990: 34). The reason for this was inferred from the fact that teachers thought differently about the purpose of practical work. Hodson (1990: 33) further indicates that those purposes are not achieved in class, because there is no "rigorous, theory–driven approach". In conclusion it is indicated that the learning outcomes of practical work are influenced by the style of the laboratory work provided and that until more focus is put on what actually learners are doing in the laboratory; the pedagogic value of practical work will remain unclear. I agree with most of Hodson's (1990) assertions.

In this study I will focus more on the link between teacher's ideas of what practical work is, its purpose and how that is conducted. The laboratory styles Hodson (1990) indicates are influenced by the teachers' views on practical work and their objectives of performing it. The study also enhances my assumption that teachers' views of what practical work is, has an influence on how they conduct practical work.

2.6 Theory of curriculum implementation

Rogan and Grayson (2003) identified three profiles for curriculum implementation which are: the profile of implementation, profile of capacity to support innovation and profile of support from outside agencies. Profile of implementation "is in essence, an attempt to understand and express the extent to which the ideals of a set of curriculum proposals are

being put into practice" (Rogan and Grayson, 2003: 1181). Below is the table of modified profile of implementation contextualized for the natural science learning area.

Table 2.1: Modified profile of implementation (Rogan and Grayson, 2003)

Level	Practical work
1	Teacher uses classroom demonstrations to help develop concepts. Learners stay attentive and engaged. Teacher responds to and initiates questions.
2	Teacher uses demonstrations to promote a limited form of inquiry. Learners participate in closed (cook-book) practical work.
3	Teacher designs 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.
4	Teacher facilitates learners as they design and undertake long term investigations and projects. Learners design and do their own "open" investigations.

Rogan and Grayson (2003:1186) indicate that the profile of capacity to support innovation is "an attempt to understand and elaborate on the factors that are able to support, or hinder, the implementation of new ideas and practices in a system such as a school". Below is the table of modified profile of capacity to support innovation.

Table 2.2: Modified profile of capacity to support innovation (Rogan and Grayson, 2003)

Level	Teacher factors
1	Teacher is under-qualified for position, but does have a professional qualification.
2	Teacher has the minimum qualification for position.
3	Teacher is qualified for position and has a sound understanding of subject matter.
4	Teacher is overqualified for position and has an excellent knowledge of content matter.

Profile for support from outside agencies is referred to by Rogan and Grayson (2003: 1191) as "organisation outside the school, including departments of education that

interacts with a school in order to facilitate innovation". Here below is a table indicating the modified profile of outside support.

Table 2.3: Modified profile of outside support (Rogan and Grayson, 2003)

Level	Physical resources	Design of professional development	Dominant change force evoked by agencies
1	Provision supplements what exists, but not enough to support the intended changes	Information on policy and expected changes are presented to school based personnel. Typical mode is one short workshop.	Bureaucratic. Change is brought about by top down directives to bring about change.
2	Provision completely covers what is required to effect the intended change	Examples of new practices as suggested by the policies are presented to school based personnel, who are given an opportunity to engage in this practice in a simulated situation. Typical mode is a series of short workshops.	Charismatic. Change is brought about by top-down inspiration and encouragement.
3	Provision completely covers what is required to effect intended change	Professional development is designed by the school based personnel depending on which new practices they wish to implement using both the outside and inside support. Typical mode consists of both external and school-based in-service training (INSET) for two to three years.	Professional. Change is brought about by encouraging role players to embrace codes of conduct and standards of teaching and learning.
4	Provision completely covers what is required to effect intended change	Communities of practice take full responsibility for their own continued professional growth and curriculum implementation calling on outside support as appropriate. Typical mode consists of ongoing school-based and directed professional INSET.	Learning community. Change is brought about by developing communities that develop shared values and goals regarding educational practice and a commitment to put these into practice.

The theory of implementation (Rogan and Grayson, 2003) is relevant for the study as the teachers are being investigated on how they conduct practical work within the context of

the NCS. Hence it will be relevant for this study to also find out how the teacher conduct practical work reflect on how curriculum is being implemented.

2.7 Empirical study

The study by Stoffels (2005) on why one science teacher still persists with a traditional centered approach towards practical work has shown that the teacher performed demonstrations. The reasons the teacher gave were that he was focusing on observational skills of the learners, he wanted to have control over the learners, it was due to lack of resources and it was due to the workload. Stoffels (2005) also indicates that the other reason was the lack of content knowledge. The study also showed that even though the teacher was using cook book practical work tasks he changed them into demonstrations even though the book had indicated that they should be conducted in groups.

The teacher as indicated by Stoffels (2005) was defensive in his practice. The study showed that the teacher factor is crucial in practical work. Failure to adhere to the requirements of the NCS was detectable in the study. Amongst other things, his approach was teacher-centered. Hence the findings raised in the study raises concerns on the ideas teachers have about practical work and how it is conducted within the context of the NCS.

2.8 Theoretical and Conceptual framework

The theoretical framework for the study is based on the study conducted by Pekmez *et al.* (2005). The study was aimed at investigating the thinking of teachers about practical work in the context of the English National Curriculum for Science in England. Three movements that have influenced practical work in UK and the US were discussed. These are indicated in Table 2.4 below.

Table 2.4: Characteristics of movements influencing practical work

		Movement		
		Discovery Learning	**The Process Approach**	**Investigations**
Main Characteristics	**1.**	Learners expected to discover things for themselves	Motivates the identification of what scientists do and argue that this is what must be taught	The approach was on the focus that pupils should be thinking about what they are doing than simply applying the practised method
	2.	Practical work seen as the means by which pupils will develop their thinking	Content not a priority but the scientific method	The approach develops procedural and substantive understanding
	3.	This is a teaching method which leaves things open for discovery and also offers an opportunity for not discovering them	This is a teaching method that focuses on skill and neglects content	The ultimate aim is to develop problem solving skills

The following models were used in the analysis and explanations of the thinking of teachers about practical work.

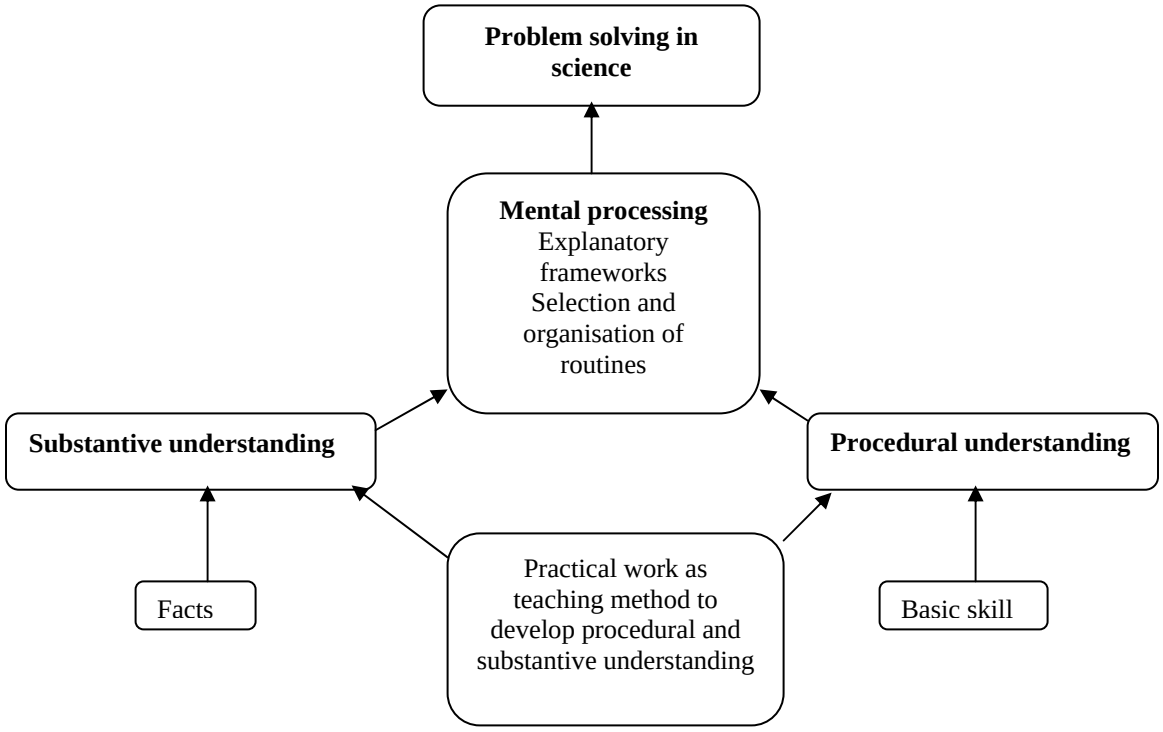


Figure 2.1 A performance model (Gott and Duggan cited in Pekmez *et al*., 2005)

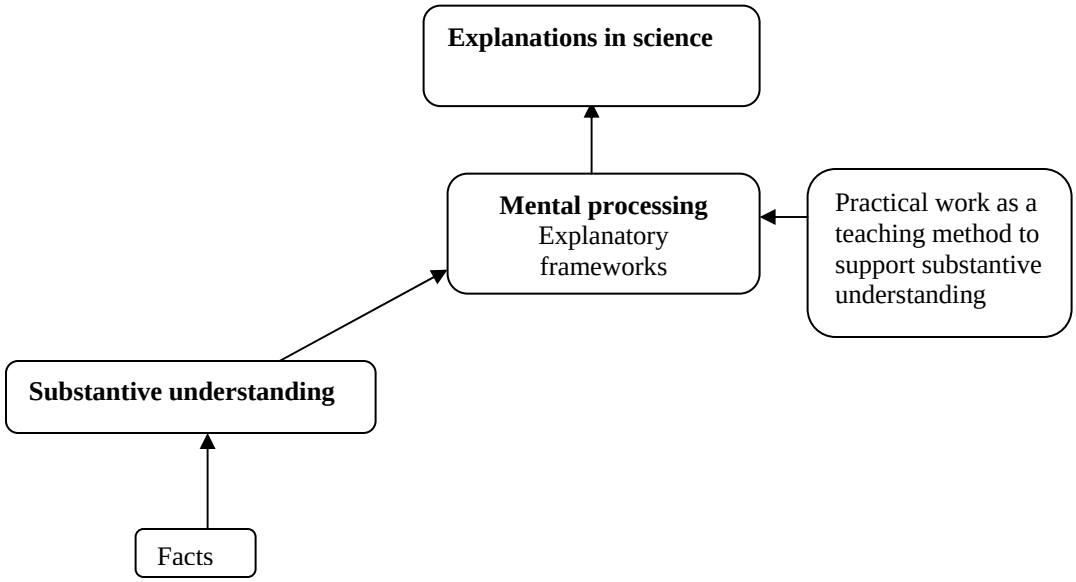


Figure 2. 2 An explanation model (Pekmez *et al*., 2005)

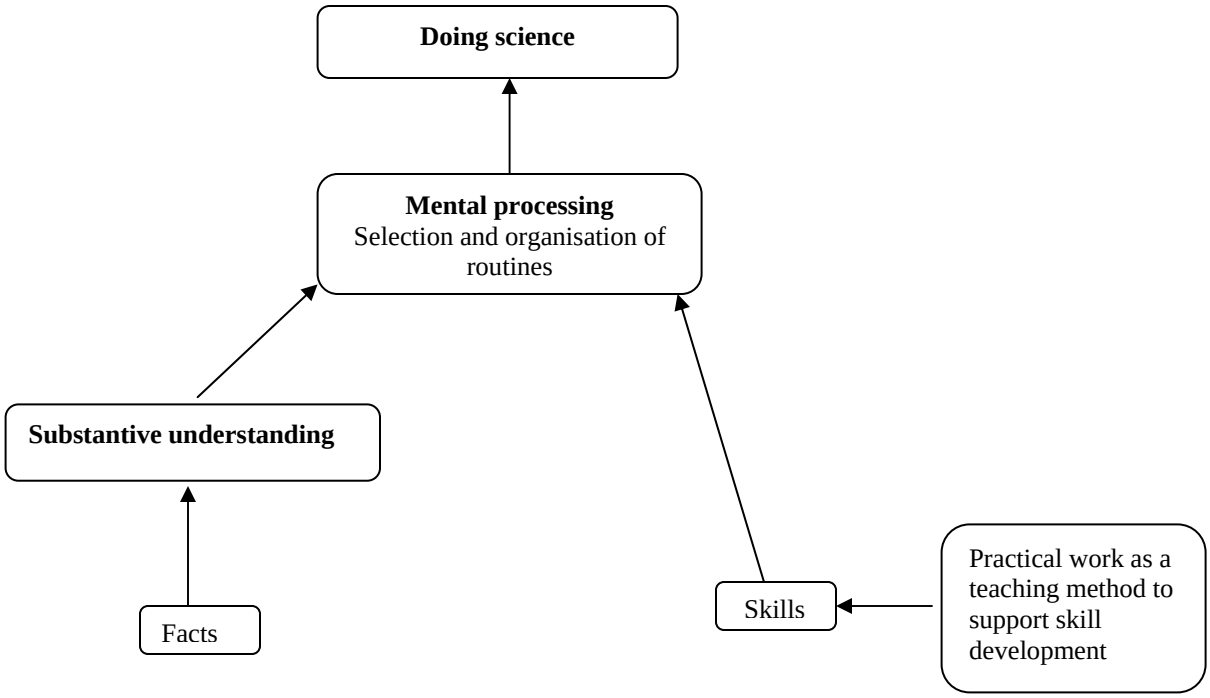


Figure 2.3 A doing of science model (based on Pekmez *et al*., 2005)

The performance model (figure 2.1) is based on the investigation movement approach. The teacher has the intention of developing substantive understanding as well as procedural understanding. Hence practical work is used as an explanatory framework and selection and organization of routines (skills) for mental processing. The ultimate goal of this approach is to develop problem solving skills amongst learners. The explanation model (figure 2.2) depicts practical work as a teaching method to support substantive understanding and laboratory work as just a teaching method towards this end (Pekmez *et al.*, 2005). Practical work is used as an explanatory framework for the explanations in science. The doing of science model (figure 2.3) uses practical work as a teaching method to support skills development. Pekmez *et al.* (2005) indicate that in this model teachers concentrate on the skills rather than ideas to be understood. This model shows a teacher who thinks of practical work from the process approach movement. These models will be used in this study in investigating how the grade 10 teacher conducts practical work within the context of the NCS.

However the study by Pekmez *et al.* (2005) was exploring the thinking of the teachers about practical work in chemistry, physics and biology across all the high school grades. This will be done differently in this study. The thinking of the teachers about practical work will be specifically for grade 10 teachers teaching physical science. The study by Pekmez *et al*. (2005) was embedded on the need to know how the new curriculum in England has brought the change in the thinking of the teachers about practical work. This study also explores the thinking of practical work by grade 10 teachers within the context of the NCS in South Africa.

How the teacher conducts practical work will be analysed using the modified model on the process of developing and evaluating a laboratory work task (figure 2.4) by Millar *et al*. (2002). According to the model, teachers' objectives and the design features of tasks (what the students are intended to learn) are influenced by the teachers' views of science and learning (what practical work is, and its purpose) and the practical and institutional context (e.g. availability of apparatus, class size and the requirements of the curriculum).

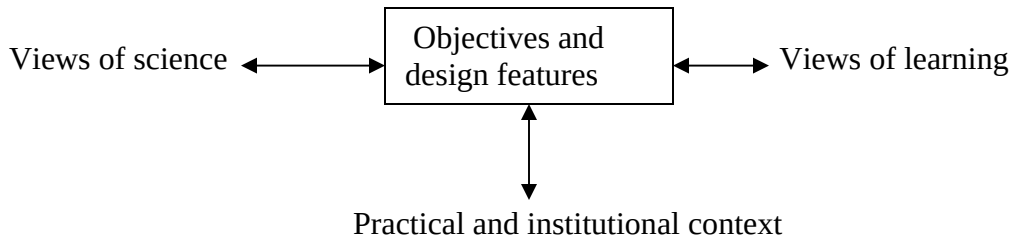


Figure 2.4. Developing and evaluating a laboratory task model (Millar *et al*., 2002)

The National Curriculum Statement (NCS) will refer to the "written document outlining outcomes, what should be taught, and suggested approaches" (Sanders, 2007). The words practical work will refer to practical investigation, laboratory work, laboratory experiences and experiments based on scientific inquiry. In this study scientific inquiry will refer to an approach that is student-centered and students have to conduct investigations or experiments (Martin-Hansen, 2003). Bennett (2003) notes that even though recent policy indicates that investigation should be given a prominent role which in this context is also evident in the NCS, different types of practical work should be

evident in the science curriculum. In the NCS this is covered by the suggestion that practical work can form part of daily assessment to cover a skill or skills (Department of Education document, 2007). Hence the practical work that could be done daily could be a variety of different types of practical work depending on the purpose it has to serve (Bennett, 2003). Procedural understanding will refer to process skills and substantive understanding to the understanding of concepts laws and theories of physical science (Pekmez *et al*., 2005).

In the next chapter I present the design of the study.

Chapter 3: Research Design

A suitable research design had to be adopted to investigate grade 10 teachers' ideas of the nature of practical work and its purpose as well as how these shape the way that the teacher conducts practical work. Hence here I will describe the research methodology which was used in this study. The research procedures and the sample and how it was chosen will also be discussed as well as a mention of how data was collected and analysed.

3.1 Research methodology

Case study methodology

In order to investigate how a grade 10 teacher conducts practical work, I used empirical evaluative research wherein an enquiry is carried in order to understand and evaluate what is happening (Bassey, 2003). I was not intending to change a situation, only striving to understand and evaluate that situation. However it was practically going to be challenging to try and understand the situations of all the grade 10 physical science teachers in South Africa.

Yin in Soy (1997: 1) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real life context…". Stake (2006: 2) indicates that "qualitative studies were developed to study the experience of real cases operating in real situations". This indicates that in a case study whatever is to be investigated the environment wherein a case is found or its context is not changed or manipulated to suit the researcher but it is studied in its real situation. Opie (2004: 74) indicates that a "case study is an in depth study of interactions of a single instance in an enclosed system". Hitchcock and Hughes (1995) hold the same view. This also indicates that the case to be studied can be a single person or single group which has common purpose. Hence as I was intending to investigate how a grade 10 teacher conducts practical work in real life situation and not all of them, the case study methodology suited my study. Opie (2004: 74) also indicated that "crucially the focus of a case study is on a real situation, with real

people in an environment often familiar to the researcher". This made sense and strengthened the conviction that this study had to be embedded in the case study methodology in that I wanted to investigate my fellow colleagues. Hitchcock and Hughes (1995: 316) also indicated that "…case study is in many ways the most appropriate format and orientation for school-based research".

The study was a descriptive case study. Hitchcock and Hughes (1995: 321) indicate that "descriptive case studies have aimed at giving a narrative account of life as it is in a social situation". The choice of the research methodology was also influenced as Opie (2004) indicates; by what can actually be done, what was practical, situational factors and interests. Within the context of the Masters programme, I was expected to complete the research in 6 months and as I was only doing the research on a part-time basis I had limited time to gather the data. Hence it was practical and feasible to adopt the case study methodology.

The studies by Stoffels (2005) on how LSM influence how a teacher conducts practical work and Ottander and Grelsson (2006) on the teachers' perspectives of laboratory work, adopted the case studies as the research methodology. The two studies are noted here because they relate well to this study.

However the familiar problem as indicated by Bassey (2003) is the generalisation from the findings of the case study and reinventing the wheel. That is a fair enough criticism, but Hitchcock and Hughes (1995) indicate that it is possible to generalise from case studies if one designed the research with the purpose of generalising from its findings. Bassey (2003: 36) also indicates that "one of the advantages cited for case study research is its uniqueness, its capacity for understanding complexity in particular contexts". This advantage is paramount to my study hence it weighs far more than the necessity of generalising from the study. Inferences and recommendations were made from the study which might have a bearing on the general understanding of how teachers conduct practical work within the context of the NCS.

3.2 Research procedures

Interviews and official documents were used in the study to gather data.

3.2.1 Official documents (practical work task reports and instruction sheets)

McMillan and Schumacher (2006) indicate that document collection is a strategy for qualitative research wherein information is obtained with little or no contact between the researcher and the participants. They further indicate that they offer a different perspective. Hence the official documents (practical work task reports and instruction sheets) were used so that they can offer a different perspective from that of the interviews conducted to probe how teachers conduct practical work. The documents were checked for their authenticity before they were interpreted (McMillan and Schumacher, 2006). Hitchcock and Hughes (1995: 324) indicate that using more than one form of data collection to obtain data is called methodological triangulation. Opie (2004: 72) calls this "triangulation by procedures". Hence in choosing the official documents I also wanted to enhance the internal validity of the study by triangulating the data with that from the interviews. Opie (2004: 70) indicate that internal validity is the "valid claim about the contents of the research study". Internal validity was necessary for the study to be trustworthy and credible (Opie, 2004)

3.2.2 Interviews

Interviews were chosen for the study as data collection means, because the research required the raw opinions of the respondents. Opie (2004: 111) indicates that

> Interviews encourage respondents to develop their own ideas, feelings, insights, expectations or attitudes and in so doing allowing the respondents to say what they think and so to do so with greater richness and spontaneity.

Opie (2004) also indicates that interviews offer the opportunity to ask the question, why? This was what I also intended to use the interviews for, to probe where necessary. Semi-structured interviews were used as they offer an opportunity to deviate from the prearranged text and wording of questions (Opie, 2004). Semi-structured interviews were

also chosen to elicit valid data as indicated by McMillan and Schumacher (2006: 353) below:

> Establishing trust, being genuine, maintaining eye contact, and conveying through phrasing, cadence, and voice tone that the researcher hears and connects with the person elicit more valid data than a rigid approach.

An interview schedule was developed wherein according to McMillan and Schumacher (2006) topics and questions are structured by the interviewer in advance. The questions were based on the research questions. This method is also mentioned by Opie (2004: 115) who indicated that in preparing an interview schedule "carefully and thoughtfully translate research questions into interview questions". However as it was a semi-structured interview I deviated where necessary. Opie (2004) also indicate that the interview schedule helps in ensuring that the interview goes well. Even though studies amongst others (Opie, 2004) indicate that in interviews, the challenge of objectivity renders them difficult to handle, that did not stop me from using them. I took care of this issue by piloting the interview schedule (Opie, 2004).

3.3 Sampling

Three teachers teaching physical science in grade 10 were used; 1 for the pilot and 2 for the main investigation. McMillan and Schumacher (2006) indicate that a sample that is chosen based on a set of criteria is called comprehensive sampling. This was done in this study. I focused on 9 schools where there was a laboratory fairly equipped with apparatus or a school that had apparatus. Rogan and Grayson (2003) indicate that resources do influence the implementation of new ideas. Hence the study attempted to eliminate the factor of lack of apparatus for conducting practical work in a particular way. A qualified physical science teacher from college or university with at least 2 years experience in a particular school was suitable for the study. Rogan and Grayson (2003) indicate that teachers' own backgrounds, training and level of confidence and qualifications do influence implementation of new ideas. Hence I did not want that to be a factor for conducting practical work in a particular way.

The participants in this study were two teachers who were called teacher M and teacher B.

Teacher M has been teaching at a former model C school for a period of 5 years and is about to complete an honours degree in education. Teacher M also taught grade 10 in 2006 and attended the NCS orientation workshops. The school is functioning and the laboratory is equipped.

Teacher B has a three year secondary teachers' diploma (STD). He has been teaching at a township school for three years and has a total of 10 years of teaching experience. He also taught grade 10 in 2006 and attended the NCS orientation workshops. The school where teach B teaches is adequately functional and the laboratory is well equipped.

3.4 Pilot study

For the results of the study to be believable the procedures used to collect the data had to be valid. Wellington cited in Opie (2004: 68) indicates that "validity refers to the degree to which a method, a test or a research tool actually measures what it is supposed to measure". Hence a pilot was undertaken to validate the instrument. White (2002:69) indicates that

> In all cases it is essential that newly constructed instruments, i.e. in their semi final form, be thoroughly pilot-tested before being utilised in the main investigation. That ensures that errors of whatever nature can be rectified immediately at little cost. It does not matter how effective the sampling or analysis of the results is, it remains a fact that ambiguous questions lead to non-comparable responses; leading questions lead to biased responses; and vague questions lead to vague answers.

In agreement with White (2002), the interview schedule had to be tested for its validity and objectivity. The description of the documents was also piloted and the supervisor helped in correcting what the final description should look like. Two teachers were earmarked for the pilot. However one of them kept on postponing the appointment. I ended up using only one teacher. Some of the lessons learnt from the pilot:

1. There were too many questions asking the same thing in the original interview schedule. This was corrected in the final interview schedule.
2. Some of the questions were vague. This was solved with the help of the supervisor in the final interview schedule.
3. The interview schedule was too long hence the interview took too long. The transcribed document was 16 pages long. Hence some of the questions were merged into one in the final interview schedule.
4. I had not made a copy of the interview schedule hence I was reading from the lap top. The screen just went blank in the middle of the interview. In the final interviews I had a hard copy of the interview schedule and extra cassette and batteries in case something went wrong.
5. I had intended to use lesson plans as part of the official documents but the teacher did not have lesson plans hence this prepared me that I might not find them in the respondents I would focus on the study. This became a reality; however I was ready for that.

The pilot also gave me an opportunity to practice appropriate gesture and facial expression (Fraenkel and Wallen, 1990). The information gathered from the pilot and the supervisor's comments helped in an attempt to make the final interview schedule objective, reliable and valid. The pilot also presented an opportunity of dealing with contextual factors like the power relationship (Opie, 2004) between the researcher and the interviewee. The respondent was visited and called frequently to establish a relationship and trust. This was also done with the respondents used in the main investigation. Piloting would enable the elimination of the points of bias (McMillan and Schumacher, 2006) if any had been manifested during the interview. However this was not the case.

3.5 Data collection

Letters (Appendices A and B) were sent to nine schools in district 9, 10, and 11. The districts were chosen for convenience. Five schools did not respond. Four schools responded. One school was used for the pilot. The other two were used for the

investigation. One kept on postponing the appointments without any valid reason. Before data could be collected I visited and called the respondents many times mostly once a week. This was to establish a relationship and take care of power relationships as already discussed. Hence data was collected over a period of two months. Samples of practical work tasks (laboratory reports) conducted in 2007 were collected from the two teachers. Teachers chose the sample practical work tasks from the learners laboratory reports in my presence, which best represented what they wanted their learners to do. This was done to enhance the authenticity of the laboratory reports (McMillan and Schumacher, 2006). Interviews were conducted after school hours to avoid disturbing the normal running of the school. A tape recorder was used to record the interviews. The practical work tasks and instruction sheet were photocopied and I used the copies. The interviews were conducted in the laboratories of each respective teacher. However, as McMillan and Schumacher (2006) indicate, notes were taken during the interviews which were also used in the data analysis. The recorded interviews were then transcribed.

3.6 Data analysis and Interpretation

Sample of practical work tasks and instruction sheets were described in a tabular format. The description was simply the description of what I saw on the official documents. This was to attain primary descriptive validity which according to Maxwell (1992: 284) is the description "of what the researcher reports having seen or heard". The interviews were transcribed such that the final record had accurate verbatim data and the researcher's insights (McMillan and Schumacher, 2006).

Hatch (2002: 148) indicates that " analysis means organizing and interrogating data in ways that allow researchers to see patterns, identify themes, discover relationships, develop explanations, make interpretations…". All this was done in order to make sense of the data (Hitchcock and Hughes, 1995). However Hitchcock and Hughes (1995: 299) also indicated that this can be achieved by "sorting the data into manageable units" which involves breaking data into categories. This was done in this study.

Research questions, common sense, personal experience and theoretical and conceptual frameworks were used to formulate initial categories to guide data analysis. Hatch (2002: 161) calls this approach of data analysis typological analysis. He also indicates that it is very efficient even though it has the potential of blinding "the researcher to other important dimensions in the data" (p.161). This approach was also mentioned by Stake (1995:78) who indicates that in data analysis for case studies " often the patterns will be known in advance, drawn from research questions, serving as template for analysis". The categories and codes were validated by the supervisor (Wellington cited in Opie, 2004). However it did not mean that new patterns and categories that arose as the data was analysed were ignored. As the data was analysed patterns and categories that emerged were used. This is also supported by Stake (1995) who indicates that sometimes patterns emerge unexpectedly hence it is important to go through the data for new categories.

Summary sheets for each typology were constructed based on reading the data from the interview scripts (Hatch, 2002). The summaries were then coded using categories formulated. Tables were used to visualise the frequency of certain categories. Frequency tables showing teachers' ideas were validated by the supervisor. Direct quotes were used when presenting results. Opie (2004) indicates that this brings life to the findings. The analysis of the data for meaning was reached "through direct interpretations of the individual instances and through aggregation of instances" (Stake, 1995:74). Hence the interpretations were grounded (Maxwell, 1992) in the language from the documents and the interviews. The interpretations from the interviews were substantiated with data from the official documents (McMillan and Schumacher, 2006). This was to enhance the trustworthiness and credibility of the study (Opie, 2004 and Maxwell, 1992).

3.7 Ethics

The ethics guidelines as described by the University of the Witwatersrand, Johannesburg, ethics committee were used to guide the study. The letters sent to the different schools were written and verified by the supervisor. This was to ensure that they contained adequate information for the possible respondents about the research. The letters were seeking permission and outlining the intentions of the research from the headmaster and

the physical science teacher. After the comments from the supervisor the research proposal also containing letters was sent to the University of the Witwatersrand ethics committee. Permission from the ethics committee was granted to conduct the study. Suggested amendments were implemented in the final letters sent to nine school (Appendix A and B). A research request form was also filled and submitted to the Gauteng Department of Education documents. Hence all the relevant stakeholders were consulted.

The problem of social power as purported by Opie (2004) was also a concern that could hinder accessibility to my respondents. I feared that respondents could just agree or disagree to be part of the study because of the degree I would be awarded after submitting the research report. However to counter this possible problem I intended to visit my possible respondents. But due to work commitments and limited time I could not. Hence it could be the reason why only four schools responded. Written permission from the respondents and the headmasters that responded was requested and granted.

However the relationship suitable for conducting a research was established with three teachers out of four. I called the teachers frequently engaging them in a conversion about various issues pertaining to school work and sometimes just paying them a visit. After some time the teachers could talk to me with a bit of freedom to express themselves the way they wanted. The fourth one dishonored all the appointments without any valid reasons and was no longer considered for the study.

Research procedures were disclosed to the respondents. A promise was made to the respondents that apart from describing and interpreting the official documents and interviews related to practical work nothing unrelated will be part of the data to be analysed. The respondents were also assured that after the report has been written the data collected will be destroyed. It was also communicated to them that their identities and their school names will not be divulged. Hence the teachers were called teacher M and teacher B in this study.

Opie (2004) indicates that if the research is only intended for the researcher to be awarded a qualification then it is unethical to do that study. Hence it was also made known to the headmasters and the teachers that apart from the researcher obtaining a qualification, the results can be presented in educational conferences and that the results will also be made known to the facilitators and the respondents. Hence this was neither a covert research nor a rape research (Opie, 2004).

The issue of how to probe for responses without offending the respondents was also a factor. This was countered by piloting the research procedures. All the instances that had characteristics of being offensive were noted and necessary caution was exercised when interviewing teacher M and teacher B.

For the reader of the report of this study it is imperative for me to disclose my epistemological and ontological perspectives (Griffiths, 1998, Hitchcock and Hughes, 1995). My assumptions are that multiple realities exist and knowledge is constructed by the knower modified by his experiences in the world (Hatch, 2002). Hence the teacher's ideas of the nature of practical work and its purpose will be the ideas he/she constructed through experiences of different kinds or just reason.

Opie (2004: 31) indicates that "researchers should be prepared to 'own' their work and the most immediate and obvious way of doing so is to say 'I' ". This was done in this study.

In the next chapter I present the results and analysis of the data.

Chapter 4: Results and Analysis

In this chapter I present how the typological model for this study was developed and implemented, the results of the study as well as the analysis. The results are presented in three stages. In the first stage I present the ideas of the two teachers of the nature of practical work, as well as the types of practical work. In the second stage I present the ideas of the two teachers of the purpose of practical work. In the last stage I present the results of how they conducted practical work. The analysis then follows.

4.1 Typological model

The first two research questions (teacher's ideas of the nature of practical work and teacher's ideas of the purpose of practical work) were used as the typologies for the study. The typology of the teacher's ideas of the nature of practical work was paired with the types of practical work. This was done because Bennett (2003) indicates that there should be a relationship between the nature and the type of practical work which would in turn help in the context of this study to analyse the teacher's ideas of the purpose of practical work. The third typology was how practical work was conducted. This was based on Millar's model of developing and evaluating laboratory task (Millar *et al.*, 2002). Hence this typology enabled the researcher to analyse how the teacher conducted practical work. The typology took into consideration how teachers' views of science and learning (which in this context were the nature of practical work and its purpose and the practical and institutional context) influenced the objectives and design of the practical work task (what the teacher intended the students learn).

The definitions of practical work and its purpose from the literature reviewed in this study were used as categories for analysing the interviews and the official documents. Practical and institutional context like class size amongst others were developed from personal experience, common sense and the theoretical and conceptual framework of the study. Hence the study adopted a typological analysis model (Hatch, 2002). However some categories for example 'to cater for different learners' which was the purpose of practical work and 'discipline' which was the practical and institutional context, amongst

others emerged as the data was being analysed and were used (Stake, 1995). Categories were given codes as shown in Tables 4.1, 4.3 and 4.5. The categories and codes were validated by the supervisor.

The interviews were read with one typology in mind and a summary sheet created for each typology per teacher (Hatch, 2002). The summary sheet contained only the main ideas of the respondent with no interpretation (Appendices G and I). This was done to attain primary descriptive validity (Maxwell, 1992). The summaries for each typology from the interviews were then coded using the categories developed (Tables 4.1, 4.3 and 4.5). The official documents were also coded using the same coding systems used for the interviews. However summaries were not created as there was not a large quantity of data. Teacher's ideas based on the codes were then tallied and frequency tables generated per typology per research procedure (Tables 4.2, 4.4 and 4.6). The frequency table enabled me to identify the main ideas from each typology based on the tallies. Hatch (2002: 158) indicates that "the last step in the typological model is to go back to the data to select powerful examples that can be used to make your generalisations come alive for your readers". This was done in this study when presenting results. This was also to enhance the trustworthiness and credibility of the study (Opie, 2004 and Maxwell, 1992). The results were also validated by the supervisor. The supervisor coded the data independently to check if his results were the same as mine. There were minor differences in the tallies of code HA of which mine was 4 and his 5 and HE of which mine was 5 and his 4. However this did not change the results significantly because the difference was 1. For all the other codes the tallies were similar.

4.2 Results

Stage 1: Teachers' ideas of the nature of practical work and types of practical work

Table 4.1 below shows the categories and codes used to analyse teachers' ideas of the nature of practical work and its types.

Table 4.1: Categories and codes of the nature and types of practical work

CATEGORY	CODE
Nature of practical work	
Learning situation that offers learners an opportunity to practice the process of investigation	WS
Teaching and learning activities in science which involves students at some point in handling or observing real objects or materials they are studying	WH
Individual or small group laboratory work	WG
Practical work is the means for discovery learning where in learners develop their thinking	WD
Methodology that will give opportunities to learners to practice what scientist do when they are being scientist	WP
An approach that develops process skills and enhance their understanding of concepts, laws and theories of physical science	WI
Difficult to classify	WDC
Teacher demonstrations to enhance learning	WT
Types of practical work	
Skills	TS
Observations	TO
Enquiry	TE
Illustration	TI
Investigation	TV

Table 4.2 presents the frequency of ideas of the nature of practical and its types in various categories. The table also offered a visual perspective of the results.

Table 4.2: Grade 10 teachers' ideas of the nature of practical work and its types

code	Frequency of ideas for teacher M from official documents	Frequency of ideas for teacher M from interviews	Frequency of ideas for teacher B from official documents	Frequency of ideas for teacher B from interviews
WS				1
WH		2		
WG		3		
WD				
WP				
WI		3		
WT		3		
WDC				2
TS				
TO		3		
TE				
TI	1		3	
TV	4		5	4

Below is the presentation of the results supported by comments from the teachers, based on table 4.2. Results for teacher M are given followed by the results for teacher B.

Teacher M

Table 4.2 shows that teacher M had a wide range of ideas about practical work. The ideas ranged from indicating that practical work is an approach that enhances understanding of the content of physical science. This is evident in this explanation which the teacher gave about practical work:

> Practical work as it says practical is something that they do it by themselves. Eh they use equipment which we call them apparatus and then to prove or to reinforce what they have learnt in class. So practical work I will take it that way. It is when they are using apparatus and equipments to reinforce what they have learnt during the lesson or sometimes you can use it. It depend which method you are either using deductive or inductive method. So you can start with the practical so that you can explain some concepts or you start with the concepts and use practical to explain it. (Teacher M interview, line 9-14)

Teacher M also considers practical work as individual or small group pupil laboratory work. This is evident from this statement from the interview.

> I think it work together because one if you demonstrate it they do not get the feeling of that thing they do not get the feeling that they did it by themselves but the best thing is to minimise group, have a group of two to three but if you have a group of five to eight then it becomes a problem. But if it is about three in a group then they work very nicely but you can start by demonstrating. (Teacher M interview, line 31-34)

It is also shown in Table 4.2 that teacher M's ideas of what practical is, are based on the fact that practical work is a tool for the teacher to enhance learning. Hence practical work is also demonstration. This is evident by what he said in the interview: "So if you demonstrate you know exactly what you want them to see. So demonstration sometimes they help a lot they do not mislead learners but in group work sometimes some group will work some group will not" (Teacher M interview, line 25-28).

As indicated in Table 4.2 the three main ideas; practical work as an approach that develop process skills and enhances understanding of content of physical science, practical work as individual or small group pupil laboratory work and practical work as demonstrations, were the ones which frequently appeared during the interviews. However the idea of practical work as the teaching and learning approach where learners discover things by themselves also transpired. This is evident from this excerpt "I mean it is self discovery they discover things by themselves without being led by the teacher". (Teacher M interview, line 28-29)

It was also evident as shown in Table 4.2 that teacher M preferred students to conduct observations. This can also be supported by what he said in the interview.

> But if it is about three in a group then they work very nicely but you can start by demonstrating for them let say you have a double lesson, spend 10 minutes just showing them how they are going to do it. And then you ask them to do it by themselves, in that way ee they learn better. (Teacher M interview, line 34-36)

Hence this supports the fact that even if the learners were to conduct a practical work task the teacher will still want to demonstrate first. However from official documents (practical work task reports and instruction sheets) a different perspective was extracted. Teacher M conducts illustration and investigation type of practical work as shown in Table 4.2. One of the practical work tasks (Appendix D) analysed had some characteristics of an investigation. This was evident from the fact that the task required learners to use general procedural skills in their venture to comprehend determination of the period as well as the frequency of the ticker timer. The other practical work task (Appendix D) done in teacher M's class had the characteristics of observation and illustration. The task was performed by the teacher to illustrate the magnetic field pattern around a magnetic bar with the learners as observers.

Teacher B

In teacher B's case one idea was very evident from the interviews. However it was not easy to code that main idea because it had the characteristic of ideas of what practical

work is from various categories which were used in the analysis of this study. In the end the idea could within the parameters of this study and its intentions best fit in the category that indicates that the teacher considers practical work as those learning situations that offer learners an opportunity to practice the process of investigations. This is evident from this statement

> According to my understanding practical work is that investigation that you engage learners into the investigation, practical something that they will do themselves, they are involved in conducting that kind of practical work and they do a particular research, not really a research they investigate but to investigate something they are given until they prove that particular thing. Right they see the results they observe what is happening, they collect or gather the apparatus or chemicals and each one of them touch. They have a feel of those particular results they were looking for. (Teacher B interview, line 10-16)

Teacher B also indicated that "practical work is when you move from theoretical and get to literal things" (teacher B interview, line 39-40). On probing, I could then make sense of the statement that teacher B uttered. The teacher wanted to indicate that practical work is the learning situation that offers opportunities to learners to put theory into practice. Upon probing further teacher B also indicated that practical work is something that "you do until you get the things right" (teacher B interview, line 43). These two ideas made it very difficult for me to link them with a particular category. Hence in the end I coded these ideas as difficult to code.

Determining the type of practical work teacher B knows or conducts was also difficult. The following statement convinced me that teacher B is sure that what he is doing is an investigation:

> Err because it gives learners that chance to observe like by themselves to see like it gives them that chance to see and observe what is going on in that practical and they do it themselves as a group together they do their own investigations. (Teacher B interview, line 24-26)

The classification investigation also came out many times in the interview which further influenced me to classify investigations as the type of practical work teacher B knows.

Teacher B also indicated that he prefers conducting investigations after indicating that the two types of practical work that he knows are the investigations and the research practical. The official documents also had the characteristics of the investigations. I was surprised after analysing one of the practical work tasks for teacher B because I found that the sample of the learners' laboratory reports were similar even though the cover pages showed that the sample laboratory reports were of learners from different groups. Hence I concluded that the practical work task is an illustration type of practical. Even though the task had the characteristics of an investigation the, the teacher coached them on how to write reports.

Stage 2: Purpose of practical work

Table 4.3 shows the categories and codes used in the analysis of the teacher's ideas of the purpose of practical work

Table 4.3: Categories and codes of the purpose of practical work

CATEGORY	CODE
Purpose of practical work	
Substantive understanding	PS
Procedural understanding	PP
Motivation	PM
Communication	PC
Enjoyment	PE
Assessment	PA
Difficult to classify	PDC
Develop group work skills	PG
To cater for different learning styles	PD

Below is the table which shows the frequency of ideas of the purpose of practical work.

Table 4.4: Grade 10 teachers' ideas of the purpose of practical work

Code	Frequency of ideas for teacher M from official documents	Frequency of ideas from interview for teacher M	Frequency of ideas for teacher B ideas from official documents	Frequency of ideas from interview for teacher B
PS	4	6	1	11
PP	7	9	1	7
PM		5		
PE		4		2
PA	1		1	
PDC				1
PG		3		2
PD		2		

Below is the presentation of the results supported by comments from the teachers based on table 4.4. Results for teacher M are given followed by the results for teacher B.

Teacher M

It is evident in Table 4.4 that teacher M has a variety of ideas of the purpose of practical work. The most frequent idea of the purpose of practical work was that of general procedural understanding. This is evident from his statement:

> Hey ja, interpretation skills, observation, analysing because those skills you will get it back when they are doing their laboratory reports, because after they have done everything, they have to present it to you, explain it to you, what does it mean…. (Teacher M interview, line 94-97)

Substantive understanding was also the second most frequent purpose of practical work evident from the interviews. This is evident from the statement "… the second reason it is to make them understand some concepts better" (Teacher M interview, line 55). Hence teacher M conducts practical work to enhance the comprehension of the content.

Practical work as the motivating tool for the understanding of content and for doing or choosing science was also mentioned by teacher M. This is evident from the statement "And you notice most of the science learners they love to do things that is why they do science. So if you don't do practical work, you miss those learners" (Teacher M interview, line 57-59). Enjoyment was also evident from the interviews as the purpose of practical work. Teacher M indicated that "the reasons most learners they love science because it is fun. Practical work it is fun. It is entertaining to them because if you teach and don't do practical work they don't enjoy it" (Teacher M interview, line 53-54).

Developing group work skills was also evident from the interviews even though it was not as frequent as the other purposes of practical work mentioned earlier. Teacher M indicated that

> So they appreciate and respect for one another and obvious the sense of belonging. Those are the things that are quite during in the lesson when they are doing group work. (Teacher M interview, line 147-149)

Hence the response was classified as the teacher's idea that the purpose of practical work is also to develop group work skills.

Teacher M also indicated that the purpose of practical work is to cater for different learners. The teacher indicated that "Ee you must understand you have got different people in the classroom some of them they can learn by rote learning reading the notes. Some they can learn by doing things for themselves" (Teacher M interview, line 56-57). However this idea was the least frequent code in the interview as shown in Table 4.4.

The official documents also concur with the idea that has the highest frequency in table 4.4 for teacher M. In one of the instruction sheets given to the learners the teacher gave the instruction "write a complete report of your experimental findings under the following headings: aim, apparatus, method/procedure, observation, results, interpretation of results and conclusion" (Appendix D). This emphasised that the teacher was inclined towards the idea that the purpose of practical work is to develop general procedural understanding. This idea was identified most often from the official documents (Table 4.4).

The second most frequent idea from the official documents as in the interviews was that of practical work as the approach to develop substantive understanding. The reports from the learners do show that there is some understanding called for from the practical work they have conducted. There was some evidence also of the practical work being used for assessment purpose. Marks were given on the laboratory reports

<u>Teacher B</u>

Substantive understanding was the most frequent purpose of practical work for teacher B (Table 4.4). This is evident from this excerpt

> Exposing learners to the, err meaningful learning to allow learners to move from theory to reality of learning. Because when we bring the concept of practical now it becomes something that has to do with them knowing and doing a thing, it is a verb doing something. It is not something that is being done by someone and writes a book about it. So themselves they learn more about that particular thing. (Teacher B interview, line 50-54)

So the statement shows that the teacher considers the purpose of practical work as that of developing substantive understanding.

The purpose of developing general procedural understanding was also evident from the interviews and the second most frequent code as indicated in table 4.4. Teacher B indicated that

> I started by saying to my learners that we need to collect certain information from point A, we collected data to say we are starting from there. And then after collecting the data let us use that collected data to implementation to apply that collected data. And after applying data we can still analyse that particular data and do some calculations until we arrive to particular conclusion so those were the process skills that I followed. (Teacher B interview, line 92-96)

The following statement shows that the teacher also considered practical work as a means of developing group work skills: "…I wanted to check if my learners will work in groups…" (Teacher B interview, line 136) However this purpose was not the most frequent one as well as the purpose of using practical work for enjoyment. It was also evident in the interview as shown by this statement "err actually mina I believe that a practical should be at an atmosphere that will be interesting and should be created" (Teacher B interview, line 149-150). The teacher considered practical work as having the purpose to create a learning situation that is interesting.

The official documents showed that the teacher had the ideas of the purpose of practical work as the means of developing substantive understanding as well as procedural understanding (Table 4.4). The two ideas were equally tallied on the table, even though it was not the highest frequency. The idea of using practical work for summative assessment was also highly evident from the official documents. The laboratory reports had a cover page with a grid and different skills to be assessed with mark allocation.

Stage 3: How practical work was conducted

Table 4.5 shows the categories and codes used in the analysis of how practical work was conducted

Table 4.5: Categories and codes for how practical work was conducted

CATEGORY	CODE
How practical work was conducted	
Practical and institutional context	
Apparatus	HA
Requirements of the curriculum	HR
Discipline	HN
How students were intended to learn	
Performance model	HP
Explanation model	HE
Doing model	HM
Outcomes	HO
Demonstration	HD
Group work	HG
Work sheet to be followed	HW

Table 4.6 shows the frequency of the ideas of how students were intended to learn as well as how the practical and institutional context played part in how the practical work task was conducted.

Table 4.6: How practical work was conducted

code	Frequency of ideas from official documents for teacher M	Frequency of ideas from interview for teacher M	Frequency of ideas from official documents for teacher B	Frequency of ideas from interview for teacher B
HA		4		1
HR		1	5	6
HD		11		
HP	4		3	
HE	4	2	4	1
HG		3	6	1
HM		1		
HO	1	1		
HW	1	1	1	
HN		5		

Below is the presentation of the results supported by comments from the teachers based on table 4.6. Results for teacher M are given then followed by the results of teacher B.

Teacher M

Teacher M preferred conducting practical work as demonstrations amongst all the other approaches of conducting practical work which were evident in the interviews (Table 4.6). This is evident from the following statement

> …I demonstrated, because now the danger with this if you do, if you let them work in groups you loose compasses and they mess up with iron filings. So they play around with the magnets they love playing around…. (Teacher M interview, line 152-154)

The interviews also showed that teacher M conducted practical work in a particular way due to discipline issues and the amount of apparatus. These two aspects were respectively the second and third most frequent aspect that influenced how teacher M conducted practical work. Hence in choosing how to conduct practical work the teacher would take disciplinary issues within the context of the working environment as well as the availability of apparatus into consideration. This is evidenced by his response

> What controls me to do demonstration or group work quite often; Firstly it is do I have enough equipment and secondly it is the type of class you are working with. There is a type of class that you know that if I give this class, they will work but if you have got a very big number of classes and uncontrollable you can't just give them apparatus to work with them. So the best thing is because your aim you want them to learn after all you are only interested in that not that they have fun. (Teacher M interview, line 132-137)

Apart from the fact that the teacher indicated in the beginning of the interview that the types of practicals are demonstrations and group work, demonstrations cropped up more frequently than group work as it is evident from the frequency table. However there was some evidence as in this statement that teacher M also conducted practical work as group work

> Err and also there is this thing in working together, there is this thing of belonging, they appreciate what they have done. Quite often because they know that, that work was done by them. Not by the teacher and secondly there is that sense of belonging if somebody is working with a group. (Teacher M interview, line 140-143)

There was also some evidence that teacher M conducted practical work as a tool to develop his lessons. This is evident from this statement “At least you cannot do all of them I just take one which is the core which is the central one where I am going to build my lesson”. (Teacher M interview, line 179-180)

There were some instances in the interviews that showed that teacher M was also influenced by a need to satisfy the requirements of the national curriculum. It is also worth acknowledging that teacher M also showed some instances of conducting practical work to develop skills with the intention of enhancing conceptual understanding. This was evident from this statement

> This one I just explained to them what they had to do. They did it themselves get the ticker timer, put the tapes, time it when it is running down the trolley and then working out, so they learn how to use the stopwatches again once I am teaching because they have to learn how to use a stop watch and then setting up, they had to set up everything themselves. I don’t do it they go through this it has instructions. Finally it is a simple thing here aim is to work out the period. (Teacher M interview, line 162-166)

Teacher M also showed from the interviews that sometimes the aim influences how practical work is conducted. It was also evident from the interviews in one of the instances that the teacher prefers giving learners a worksheet to follow.

It was evident from the instruction sheet and the laboratory reports that the teacher used the practical work to enhance the understanding of a particular concept. Because one of the instruction sheets had the diagrams as well as all the apparatus learners had to use and a full description of what to do, and they were asked to investigate magnetic field around permanent magnet (Appendix D). In the other practical work task which was for determining frequency the instruction sheet had LO1 and ASs to be attained. Learners were also given headings to use when writing the report (Appendix D). The laboratory reports for this practical work task showed that the teacher intended them to develop general procedural understanding as well as substantive understanding. Hence the teacher

conducted practical work within the confines of the performance model at this stage as well as the explanation model.

Teacher B

It is evident from table 4.6 that teacher B mostly conducted practical work to satisfy the requirements of the national curriculum. This is evident from this statement "… as requested in the guidelines they should do two" (Teacher B interview, line 141). However teacher B also indicated that even though the assessment guideline requested two practical work tasks, they did six as indicated in this statement "it was simply exposing them and it gave me a variety of choice to say, I will choose this two after doing the practicals and I think it assisted me in a way to make them understand the subject content more" (Teacher B interview, line 141-143). Hence the teacher also conducted practical work to enhance the understanding of the learners.

The interviews also showed that to a certain extent even though not that explicitly the teacher conducted practical work as a group work and that apparatus did not influence how practical work was conducted because the laboratory was fully equipped.

The official documents showed that the practical work tasks were conducted in groups because there are names of the group members on the cover pages. However as indicated before in one of the practical work task learners had the same reports even though they were in different groups. The laboratory reports and the instruction sheets carried the heading "portfolio practical" which showed that the tasks were conducted to satisfy the requirements of the national curriculum (Appendix D).

The official documents perused also showed that teacher B was operating partially within the performance and largely within the explanation model. The reports showed that the students were intended to develop general procedural understanding with the intention of developing substantive understanding. Because learners where told how to set up the apparatus as well as which apparatus to use and then investigate voltage. It was also evident from the official documents that the teacher used practical work as a teaching

method to support substantive understanding. There was also some evident from the instruction sheet that learners were expected to follow a detailed instruction sheet.

4.3 Analysis

Nature of practical work

Teacher M's ideas of the nature of practical work, are fundamentally based on the notion that practical work is a teaching tool as well as a learning tool. The teacher considers practical work as the teaching tool that offers learners an opportunity to develop process skills (Stoffels, 2005). Practical work is also an approach that enhances learners' understanding of content. Hence these ideas partially fit within the parameters of the investigation movement (Pekmez *et al*., 2005). This is partially so because there was no intention of developing problem solving skills.

To teacher M, practical work can be a group work task or individual task. This would mostly be how Donnelly (1998) considered what a practical entails. But Donnelly (1998) does not consider this laboratory tasks as teacher demonstration where learners are observers, which it was largely the case for teacher M. However teacher M's ideas of the nature of practical work also had some characteristics of discovery movement (Pekmez *et al*., 2005) because the teacher also indicated that learners in practical work have to discover things by themselves. However this idea did not appear again in the interview.

Teacher B's ideas of the nature of practical work, were difficult to harness within a particular frame of explanation. However the ideas were fundamentally based on the fact that practical work is a teaching and learning tool wherein learners practice the processes of investigation (Stoffels, 2005). Processes of investigation according to Stoffels (2005) were referring to process skills. Teacher B's ideas would best fit within the process movement (Pekmez *et al*, 2005) because the doing of science part was stronger than the emphasis behind the doing of science (content driving the practical work task). But the official documents had the characteristics of the investigation movement (Pekmez *et al*., 2005), even though again there was no evidence of the intentions of developing problem

solving skills. Besides the process skills that were evident, content was also used to drive the practical. Sample of two practical work tasks were used. This did not result in any distortion on the analysis of data because the sample of two practical work tasks was chosen to identify any discrepancies, which were identified as indicated before. Therefore this did not have a negative impact on the study. The ideas of teacher B of the nature of practical work can be classified as ranging from the process movement to the investigation movement.

Both teacher M and B's ideas had the characteristics of the investigation movement, even though partially as indicated before. It should be noted that teacher M's ideas were largely inclined towards the investigation movement than teacher B. However they also differed in that teacher M's ideas had also the characteristics of the discovery movement whilst teacher B's ideas had the characteristics of the process movement. It should further be noted again that teacher B's ideas were largely inclined towards the process movement.

Types of practical work

Teacher M demonstrated one of the practical work tasks, with learners observing so that they can relate that to the ideas (Gott and Duggan, 1995, Bennett, 2003) they had about the content. The teacher used this practical to illustrate certain concepts whilst learners observe. The reasons teacher M gave of why he preferred to demonstrate whilst learners observe were in line with what Johnstone and Al-Shuaili (2001: 44) who said that demonstration helps to "suppress noise and focus attention on the salient observation". However in the study by Stoffels (2005) it was found that the teacher can use demonstrations just for defensive purposes. Hence the reason the teacher gave could be for defensive purposes or to suppress 'noise'.

Hodson (1990) indicated that since 1882 people had demonstration in mind when they talked about practical work and Pekmez *et al* (2005) indicated that demonstrations were the most frequently done by teachers. It could appear that the assertions of Pekmez *et al*.

(2005) and Hodson (1990) are evident in teacher M. Hence it was not surprising that teacher M still preferred demonstrations.

One of the practicals had as its outcome problem solving skills and learners' laboratory reports had the characteristics of the investigation type of practical even though the teacher had indicated that he only knows demonstrations and group work. Group work is not a type of practical work, merely how practical work can be done. Hence teacher M's ideas of the types of practical work varied amongst observations, illustrations and investigation (Gott and Duggan, 1995).

Laboratory reports had the characteristics of an observation as well as investigation but the fact that the laboratory reports of one of the practical task were the same, teacher B used the practical work task as an illustration. He also acknowledged that he wanted them to write the report in a particular way when asked for clarification. But that he did not intend to inform them to write the same thing. The teacher indicated that he only knows investigations and practical research. Literature up to now does not show practical research as a type of practical work. Teacher B's ideas of the types of practical work also varied from illustration of particular concepts, investigation to observations (Gott and Duggan, 1995).

Both teachers' ideas of the types of practical work ranged from observation through illustrations to investigations.

Purpose of practical work

Both teachers M and B had a wide range of ideas of the purpose of practical work. Their ideas were largely based on practical work as a teaching and learning tool to enhance understanding of the content physical science as well as developing process skills. Hence for both teachers the ultimate purpose of practical work was within the confines of developing procedural and substantive understanding (Pekmez *et al*., 2005).

Pekmez *et al.* (2005) indicated that procedural ideas should be referring to a complete scientific process, wherein learners identify a question, design the task, identify instruments, collect and analyse and interpret data and conclude. However this is not what was evident from both the teachers. They focused only on learners being able to write the aim, collect data, analyse data, interpret data and write conclusions. This is called the write-up skills according to the Gauteng Department of Education documents (2006). Nevertheless Pekmez *et al*. (2005) indicated that in their study most teachers did not attempt to aim for the full expectations of procedural understanding (a complete scientific process) and they still classified the ideas as belonging to the general heading of procedural understanding. Hence the two teachers were also classified in this study as focusing on general procedural understanding. They were concentrating on using practical work more to enhance the understanding of certain physical science concepts. Developing group work skills was also the main focus for both teachers. They considered practical work as a teaching method that can be used to foster group work skills.

Teacher M also showed that he considers practical work as the tool that will enable him to motivate learners and bring enjoyment in doing the subject physical science. He also used practical work to cater for different learning styles of his learners. The ideas of the purpose of practical work which were evident were similar to the ones reported by Hodson (1990) and Bennett (2003).

How practical work was conducted

The data showed that teacher M preferred conducting practical work as demonstrations. He presented various reasons for conducting practical work either as a group work or by demonstrating. Amongst others he indicated that the amount of equipment as well as the disciplinary issues influences whether if it will be group work or demonstration. However besides all the reasons he gave, the data showed that he generally preferred conducting demonstrations. This finding is similar to that of the teacher investigated by Stoffels (2005) who preferred to conduct demonstrations. Teacher M also showed that he also conducts practical work in a particular way based on what he is aiming for as well as to satisfy the requirements of the national curriculum. According to Department of

Education documents (2005 and 2007) two compulsory practical work tasks should be conducted in Grade 10. Teacher M also indicated that he uses practical work to develop his lessons hence that also influenced how he conducted practical work.

Teacher B generally conducted practical work to satisfy the requirements of the curriculum. The data also showed that he conducted practical work to enhance the understanding of the learners. Hence how he conducted practical work was generally based on the fact that the requirements of the curriculum should be satisfied and that learners have to understand the content better

The two teachers' ideas showed more of the characteristics of being inclined towards conducting practical work within the confines of the explanation model (Pekmez *et al.* 2005). In the explanation model practical work is merely used as the teaching method to support substantive understanding (Pekmez *et al.* 2005). These were some of the characteristics from their ideas:

1. They emphasised the development of substantive understanding.
2. They emphasised the development of general procedural understanding wherein substantive understanding was enhanced.
3. They conducted mostly demonstrations so that learners can observe and enhance their understanding of a particular concept (substantive understanding).
4. The instruction sheets were also inclined towards developing substantive understanding even though learners were expected to write the laboratory reports according to the write-up skills.
5. There was no attempt to develop problem solving skills.

Even though teacher M showed some characteristics of conducting practical work within the performance model this was defeated by the fact that in practice the teacher did not attempt to develop problem solving skills even though the instruction sheet indicated that problem solving skills was one of the learning outcomes to be achieved. This did not become evident in practice. Mostly his intentions were to enhance content understanding.

Teacher B also showed some characteristics of conducting practical work within the performance model but as was teacher M there was no attempt to develop problem solving.

Table 4.7 below shows the summaries of the analysis of the two teachers' ideas of the nature of practical work, types, its purpose and how they conducted it.

Table 4.7: Summaries of the ideas of practical work

	Teacher M	Teacher B
Nature of practical work	Investigation movement Discovery movement	Process movement Investigation movement
Types of practical work	Illustration, investigation, observations (demonstrations)	Illustration, investigation, observations (demonstrations)
Purpose of practical work	Develop procedural understanding, substantive understanding, group work, enjoyment and motivation	Substantive understanding, procedural understanding, group work skills
How practical work was conducted	Demonstrations Explanation model	Explanation model

In the next chapter I present the discussion and conclusion.

Chapter 5: Discussion and Conclusion

In this chapter I present the discussion and conclusion wherein I attempt to answer the research questions. The implications of the findings of the study for the curriculum, recommendations, and lessons learnt from the study and shortcomings of the study are discussed.

5.1 Research questions

5.1.1 Teachers' ideas of the nature of practical work

The ideas of the nature of practical work, for teacher M partially fit within the parameters of the investigation movement (Pekmez *et al*. 2005) because according to him, practical work develops procedural understanding as well as enhancing the understanding of the content. However as there was no evidence of developing problem solving skills, the ideas only partially fit within the investigation movement. However there was also some characteristic of discovery movement even though it was not significant throughout the interview and in the documents. Teacher B's ideas of the nature of practical work best fit within the parameters of process movement (Pekmez *et al*. 2005), because he stressed the doing of science neglecting the content. There were also some partial characteristics of the investigation movement in the official documents. Even though the documents showed that substantive understanding and procedural understanding were developed, there was no attempt as observed for teacher M of developing problem solving skills. Both teachers M and B's understanding of the types of practical work varied from observations, illustration and investigation (Bennett, 2003). The types of practical work helped to understand the ideas of teachers of what practical work is, because if the teacher indicated that he is conducting investigations whilst performing demonstrations, like teacher B, it presented another perspective on the teacher's understanding of the nature of practical work.

5.1.2 Teachers' ideas of the purpose of practical work

Developing both general procedural and substantive understanding was the main purpose for both teachers M and B. For both teachers' however procedural understanding was merely confined to write-up skills. They also used practical work as a tool to develop group work skills. Teacher M used practical work also to motivate learners, for enjoyment and to develop his lesson.

5.1.3 How the grade 10 teachers' ideas of the nature of practical work and its purpose shape how he/she conduct practical work

The idea of the nature of practical work and its purpose for teacher M best fit within the investigation movement (Pekmez *et al*., 2005). The teacher had his ideas of the nature of practical work within the investigation movement even though there was no attempt to develop problem solving skill. His understanding of the purpose of practical work was also largely based on developing procedural and substantive understanding. Hence the teacher should have conducted practical work within the performance model (Pekmez et al., 2005). However how he conducted practical work fit best within the explanation model (Pekmez *et al*., 2005). How he conducted practical work does not fit within the performance model because the teacher did not focus on developing procedural understanding (scientific process, Pekmez *et al*., 2005) and problem solving skills but focused on developing substantive understanding. Hence he used practical work as the teaching method to support the understanding of the content by learners. The write-up skills the teacher was aiming for were for the laboratory reports which would indicate to him that they (learners) understood the content better by producing well written laboratory reports.

The ideas of teacher B of the nature of practical work best fit within the process movement (Pekmez *et al*., 2005) whilst his ideas of the purpose of practical work best fit within the investigation movement (Pekmez *et al*., 2005) even though there was no attempt to develop problem solving skills. The teacher conducted practical work within the explanation model (Pekmez *et al*., 2005) and used practical work to explain the content. The teacher focused on the substantive understanding with procedural

understanding just forming part of the greater idea of enhancing the substantive understanding. Hence even though there was an attempt to develop procedural understanding in practice, the emphasis was on enhancing the content which is substantive understanding.

Grade 10 teachers' ideas of the nature of practical work and its purpose do not necessarily shape how teachers conduct practical work. The ideas of teacher M are within the investigation movement but he conducted practical work within the framework of an explanation model. For teacher B the ideas are within the process movement and the investigation movement but conducted practical work within the explanation model. The findings have revealed another perspective to Millar *et al*'s (2002) assertion that teachers views of science and learning which in this context referred to what practical work is and its purpose, influence the design and objectives of a practical work task (figure 2.4). Even though teachers' views did influence what they intended their students to learn, in practice that was not evident. Their views were in a framework different from that in which they conducted the practical work tasks.

5.2 Reasons for the difference in frameworks

The following may be some of the reasons for the difference between their views of the nature of practical work and how they conducted practical work;

1. Lack of procedural understanding

   Both teachers demonstrated lack of procedural understanding in terms of classroom practice (Pekmez *et al*., 2005). Their instruction sheets were focused on what learners were expected to do and not focused on the outcomes (Ottander and Grelsson, 2006). This perpetuated a limited focus on developing procedural understanding. Because of this lack of focus of procedural understanding and its comprehension, the attempt to develop them became just the demonstration of using or seeing how apparatus are used. Hence this may have resulted in the difference between the views teachers had of the nature of practical work and how they conducted it.

2. Institutional and practical context (Millar *et al*., 2002, figure 2.4)

   Both teachers each had a lesson lasting for 35 minutes of which sometimes they had double slots. Only so much can only be done within that limited time hence it may also be the reason they also resorted to demonstrations. The grade 10 topics are many and Perkins-Gough (2007: 93) indicates that "extensive lists of science topics in a given grade may discourage teachers from adopting more effective approaches to laboratory instruction". Hence the large number of topics to be covered with the external examinations to be written may have resulted in teachers resorting to demonstrations. Teacher M also indicated that disciplinary issues (Stoffels, 2005) also led him to conduct demonstrations. Teacher B indicated that the unavailability of the laboratory assistant hampers him from conducting many practical work tasks. This sentiment was also echoed by teacher M who also indicated that he resorts to demonstrations because of the unavailability of the laboratory assistant who will clean after him. The need to satisfy the requirement of the portfolio and Continuous assessment (CASS) also influenced the teachers to resort to demonstrations. Kapenda *et al.* (2002) also indicated that a large class was also the reason that Namibian teachers gave for conducting demonstrations, and both teachers in this study had large classes. Hence by resorting to demonstrations, this in turn resulted in the difference between their views of the nature of practical work and how they conducted practical work.

3. Lack of knowledge or skill to develop problem-solving skills and ensuring that tasks are learner-centered

   Both teachers were in charge of the tasks and to a large extent demonstrating the tasks, hence their approach was teacher-centered (Stoffels, 2005). In an inquiry approach the activities have to be student-centered (Kask and Rannikmäe, 2006) and develop problem solving skills (Department of Education documents, 2003, 2005 and 2007). Hence this deficiency in both teachers may also have resulted in

the difference between the framework of teachers' views and how they conducted practical work.

5.3 Implications for the curriculum

According to Department of Education documents (2005 and 2007) practical work has to be conducted within the framework of scientific inquiry where learners perform investigations. However this study showed that teachers conducted what they call investigations which are not really investigations. They did not attempt to develop problem solving skills. Pekmez e*t al.* (2005: 20) indicate that when "operating within a faulty framework, practical work could only succeed by accident rather than design". Indeed teachers had intentions to develop substantive and procedural understanding which is in line with what is scientific enquiry (Kask and Rannikmäe, 2006). However it was evident from this study that the way the two teachers conducted practical work was not a reflection of their views of the nature and purpose of practical work. They thought that they were doing investigations whilst they were conducting practical work within the framework of the explanation model. The ideas are present in their minds but putting them into practice was not evident. Teacher B's ideas were a bit more uncoordinated than teacher M. His ideas did not flow like in teacher M whose understanding of the nature of practical work and its purpose were within the same framework of investigation movement. Both teachers did not have learners designing the practical work tasks as required by the NCS. This then defeats the intentions of Department of Education documents (2003, 2005).

This brings into question the implementation of the curriculum. Rogan and Grayson (2003) indicate that South Africa is in danger of falling into the trap of designing visionary and educationally sound policies for the national curriculum whilst not focusing on how to implement those policies. In their theory of curriculum implementation Rogan and Grayson (2003) identified three profiles which are; profile of implementation, profile of capacity to support innovation and profile of support from outside agencies. Both teachers are operating largely at level 2 according to the profile of curriculum development (Table 2.1). They use demonstrations to promote a limited form of inquiry.

Both teachers are well-qualified, thus at the profile of capacity to support innovation (Table 2.2) they operate at levels 3 to 4. Support from outside agencies is sufficient for the implementation of the new curriculum as both teachers have adequately fitted laboratories. The above analysis shows that not much is done in terms of implementation. Rogan and Grayson (2003) indicate that it is usually the case with the developing countries. The capacity to support the teachers in terms of their qualifications is adequate however implementing the policies and the design of the professional development can be questioned. The study has shown that there is cause for concern on curriculum implementation with regard to practical work.

5.4 What can be done

The study has shown that the ideas which teachers have of what practical work entails and its purpose do not necessarily ensure that they conduct practical work according to their ideas.

What became evident in this study was that teachers were doing what they thought was developing procedural understanding whilst they were not. Hence this means that they do not understand what procedural understanding is. This finding was also reported by Kapenda *et al.* (2002). Pekmez *et al.* (2005) found that there is need "... to develop a deeper understanding of the procedural knowledge base amongst a significant proportion of science teachers". This assertion is also reported by Bennett (2003).

Kask and Rannikmäe (2006) also indicate that the collaboration within schools of the best practices in practical work should be taken into consideration. Hence the teachers themselves too are encouraged not to be derailed by the contextual factors but to stand up and introspect themselves and seek advice where necessary. Rogan and Grayson (2003: 1200) indicate that "changing teaching and learning practices should be viewed as a change of culture rather than merely a technical matter". Hence teachers themselves have the challenge of accepting the new approach, allow it to live in them and practice it. Rogan and Grayson (2003) indicate that if teachers attend workshops and fail to implement what they have learnt there will be no change.

The study by Kask and Rannikmäe (2006) has shown that intervention is very important in the evolution of the teachers towards inquiry approaches. Bennett also (2003: 96) indicates that "the messages emerging from current thinking on practical work are that the emphasis needs to shift from doing to discussions". Therefore there is need for extended time beyond what has been done to engage teachers in discussions on how to put the Department of Education documents learning area and assessment guideline policy on science enquiry into practice. Hence intervention through the cluster meetings is recommended.

However Rogan and Grayson (2003) indicate that the reason for the failure of well designed and well intentioned curricula in developing countries is the lack of a clearly thought out implementation strategy. Hence it is necessary to engage teachers on meaningful, planned discussion on scientific inquiry which would encompass both procedural and substantive understanding. Cluster meetings should be organized such that teachers in the end are able to operate at level 4 of all the profiles of theory of implementation (Rogan and Grayson, 2003). This could be achieved by scaffolding teachers into how to design and conduct practical work is. Rogan and Grayson (2003: 1197) also indicate that "to build capacity without linking it to implementation is fruitless". Hence the cluster leaders or facilitators should also take into consideration that practical work tasks moderated reflect the ideas discussed in the previous meetings and scaffold teachers accordingly. However the ultimate ideal situation should be to establish communities that "develop shared values and goals regarding educational practice and a commitment to put these into practice" (Rogan and Grayson, 2003: 1194).

5.5 Lessons learnt from the study

My assumptions were that the ideas of the teacher of the nature of practical work and its purpose are reflected when he or she conducts it. However the study has shown the possible situation of operating in a faulty framework, wherein the ideas will be within a particular framework (e.g. performance model) different from the framework of how practical work is conducted (e.g. explanation model).

5.6 Shortcomings

The format used to present the results and analysis of this study looks simplistic, because results are given and then analysed separately. This has been criticized by Opie (2004). However the format did not have an impact on the findings. The format was adopted because the typologies used were based on the research questions guiding the study which became themes (Hatch, 2002).

This study did not look into what exactly happens in the cluster meetings as well as the extent of the impact of those meetings in assisting the teachers to engage with practical work. Hence if the data from the cluster meetings was used, substantiated with the data from the teachers' interviews and documents (practical work tasks and instruction sheets), maybe that would have resulted in a different perspective to the findings of this study. However I do acknowledge that not depending on the interviews only but also observing actual practice through the official documents (practical work tasks and instructions sheets) helped in the findings of the study.

5.7 Conclusion

The study showed that there is an attempt to conduct practical work even though it is happening within a faulty framework. Stoffels (2005) indicated that teachers need their confidence to be boosted for them to operate competently. The study has shown that there is need for this. How the results of the study best represent the majority of science teachers is debatable but the findings can provoke the understanding of practical work and its implementation. The study has shown that there is a need for the link between the understanding of practical work and teacher practice for the enquiry approach to be a success. Hence it calls into question the current methods that are used to inform physical science teachers on how to conduct practical work.

References

Bassey, M. (2003). *Case study research in educational settings*. Open University press. USA

Bennett, J. (2003). *Teaching and Learning Science.* Continuum. London. 73 - 98.

Department of Education documents. (2003). *National Curriculum Statement Grades 10-12 (General) Physical Sciences*. Pretoria: Department of Education documents.

Department of Education documents. (2005). *National Curriculum Statement Grades 10-12 (General) Learning Programme Guidelines Physical Sciences*. Pretoria: Department of Education documents.

Department of Education documents. (2005). *National Curriculum Statement Grades 10-12 Subject Assessment Guidelines Physical Sciences.* Pretoria: Department of Education documents.

Department of Education documents. (2007). *National Curriculum Statement Grades 10-12 Subject Assessment Guidelines Physical Sciences.* Pretoria: Department of Education documents.

Donnelly, J.F. (1998). The place of the laboratory in secondary science teaching. *International Journal of Science Education,* 20(5), 585-596.

Fraenkel, J. and Wallen, N. (1990). *How to design and evaluate research in education.* New York: McGraw-Hill

Gauteng Department of Education documents. (2006). *Guideline Document For Continuous Assessment Portfolio Physical Science Grade 11 and 12.* Johannesburg: Gauteng Department of Education documents.

Gott, R. and Duggan, S. (1995). *Investigative Work in the Science Curriculum.* Open University press. Buckingham.

Gott, R. and Duggan, S. (1996). Practical work: its role in the understanding of evidence in science. *International Journal of Science Education,* 18(7), 791-806.

Griffiths, M. (1998). *Educational Research for Social Justice: getting off the fence*. Open University Press: Buckingham. Philadelphia, 29 - 140.

Hatch, J.A. (2002). *Doing qualitative research in educational settings.* SUNY. New York

Hitchcock, G. and Hughes, D. (1995) *Research and the teacher: A qualitative Introduction to School-based Research*. Routledge. London and New York. Pp 316 – 329.

Hodson, D. (1990). A critical look at practical work in school science. *School Science Review,* 70 (256), 33-40.

Johnstone, A.H. and Al-Shuaili, A. (2001). Learning in the laboratory; some thoughts from the literature. *University Chemistry Education*, 5, 42-51

Kapenda, H.M., Kandjeo-Marenga, H.U. and Kasanda, C.D. (2002). Characteristics of practical work in Science Classrooms in Namibia. *Research in Science and Technological Education,* 20(1), 53-65.

Kask, K. and Rannikmäe, M. (2006). Estonian Teachers' Readiness to Promote Inquiry Skills Among Students. *Journal of Baltic Science Education,* 1(9), 5-16.

Martin-Hansen, L. (2003). Defining inquiry. *The Science Teacher*, 70(2), 34-37.

Maxwell, J.A. (1992). Understanding and validity in qualitative research. *Harvard Educational Review,* 62(3), 279 – 300.

McMillan, J. H. and Schumacher, S. (2006). *Research in Education Evidence-based inquiry (6th ed).* Pearson Education. Boston.

Millar, R., Le Maréchal, F. and Tiberghien. A. (1999). 'Mapping' the domain: varieties of practical work, In Leach, J. and Paulsen, A. (Eds). *Practical work in Science Education: recent research studies.* Roskilde University Press. Roskilde.

Millar, R., Le Maréchal, F. and Tiberghien. A. (2002). Varieties of laboratory work: a way of profiling Laboratory work tasks, In Psillos, D. and Niedderer, H. (Eds). *Teaching and Learning in the Science Laboratory.* Dordrecht: Kluwer, 9-20.

Opie, C. (2004) (Ed). *Doing educational research.* Sage. London.

Ottander, C. and Grelsson, G. (2006). Laboratory work: the teachers' perspective. *Journal of Biology Teaching,* 40 (3), 113-118.

Pekmez, E. S., Johnson, P. and Gott, R. (2005) Teachers' understanding of the nature and purpose of practical work. *Research in Science & Technological Education,* 23(1), 3-23.

Perkins-Gough, D. (2007). The Status of the Science Laboratory, special report. *Educational leadership.* 93-94.

Rogan, J.M. and Grayson, D.J. (2003). Towards a theory of curriculum implementation with particular reference to science education in developing countries. *International Journal of Science Education,* 25(10), 1171-1204.

Sanders, M. (2007). Understanding the requirements of the new curriculum. *Workshop notes.* University of the Witwatersrand. Johannesburg.

Soy, S. K. (1997). *The case study as a research method*. Unpublished paper. University of Texas at Austin.

Stake, R.E. (1995). *The art of case study research.* SAGE publications. USA

Stake, R.E. (2006). *Multiple case study analysis.* The Guilford press. USA.

Stoffels, N.T. (2005). "There is a worksheet to be followed": A case study of a science teacher's use of learning support texts for practical work. *African Journal of Research in Science, Maths and Technology Education*, 9(2), 147-157.

Tsai, C. (2003). Taiwanese science students' and teachers' perceptions of the laboratory learning environments: exploring epistemological gaps. *International Journal of Science Education*, 25(7), 847-860.

White, C.J. (2002). *Research Methods and Techniques.* Pretoria University

White, R.T. (1996). The link between the laboratory and learning. *International Journal of Science Education*, 18(7), 761-774.

Appendices

Here I present the letters sent to the headmaster and the respondents. I also present the interview guide as well as the categories and codes used in the analysis of the data. The official documents descriptions are given as well as the coded analysis of the official documents. The summary sheets for teacher B and teacher M are also given per typology.

Appendix A: Letter to the headmaster

To the headmaster

My name is Awelani V. Mudau. I am a student at Witwatersrand University. I would like to ask for permission to interview and collect data from your grade 10 physical science teacher for my Master of Science research project. I am interested in investigating teachers' views of practical work within the context of the national curriculum statement. I will not interrupt the normal running of the school. My task if permission is granted would be to collect the official documents like learners' practical work reports and interview the teacher when he is available. The data collected will be treated with confidentiality. The names of the teacher and your school will not be used in the analysis of the data and the data will be destroyed after six month.

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

Do not hesitate to contact me for any correspondents arising from this letter
Home: 011 987 2494 Cell: 082 666 5450 Work: 011 615 7028 ask for ext 22
Email address: awelani@webmail.co.za

Yours faithfully
A.V. Mudau

Consent form

I _____ the headmaster/principal of _____ school hereby give consent to Awelani to involve the physical science grade 10 teacher in his investigation.

Signature: _____ Date: _____

Appendix B: Letter to the teacher

Dear colleague (Grade 10 science teacher)

My name is Awelani V. Mudau. I am a teacher at Malvern high school. I am a student at Witwatersrand University. As part of the fulfillment of the Master of Science degree I am expected to produce a research report. Hence I am interested in investigating grade 10 teachers' views of practical work within the context of the National Curriculum Statement (NCS). I would like you to be part of my study. I will collect the data from your official documents and interview you. The report from the data will be solely for the fulfillment of the degree requirements and presentation from the research can also be made in conferences only. But your names will remain confidential. You will gain tremendously from the investigation.

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

Cell: 082 666 5450

Home: 011 987 2494 Work: 011 615 7028 ask for ext 22

Email address: awelani@webmail.co.za

Yours faithfully

A.V. Mudau

Consent form

I _____ the teacher at _____ school hereby give consent to Awelani Victor Mudau to be part of his investigation. However the data that will be collected from me and my class should be used for the research presented to me by Awelani and conferences only.

Signature: _____ Date: _____

Appendix C: Semi-structured interview protocol

1. **What is practical work**

Can you tell me a bit about practical work?

What types of practical work do you know?

Which kinds of practical work do you prefer to conduct in class?

Why do you prefer the kind(s) you indicated above?

What are the types of the practical work you have conducted so far?

If you were to explain practical work to somebody who does not know, what would say is practical work?

2. **Purpose of practical work**

What is the purpose of practical work?

What was the purpose of the practical work you have conducted?

Comment on the suggestion that practical work can be used to explain laws and theories of physical science.

Comment on the suggestion that practical work can be used to develop process skills.

What does the assessment guideline say about the purpose of practical work?

Do you link the purpose with the type of practical work? Elaborate.

3. **How you conducted practical work**

When your learners perform practical work what outcomes do you want them to achieve? Elaborator.

Did you achieve the learning outcomes you were intending to? Explain.

What were the outcomes of your practical work?

How many practical work tasks did your learners perform?

Why did your learners perform the number of practical work tasks you have indicated?

If you where to change the way you conducted practical work, what would you change?

How did your ideas of practical work influence how the practical work was conducted? Elaborate.

Appendix D: Description of official documents

CODE	TYPE OF DOCUMENT		DESCRIPTION
P1M	Instruction sheet		The instruction sheet has a heading indicating the knowledge area: electricity and magnetism and Activity: magnetic field of permanent magnets. In The second paragraph there is the statement, to investigate: the magnetic field around permanent magnets. Thereafter apparatus to be used for the task are indicated. A description of what learners are expected to do follows. The diagrams and illustrations are also include in the what to do section. The last paragraph has the assessment questions
	Learners practical reports (students worksheet)	PR1L1M	The name of the learner on top. Grade class follows and the teacher's name. The aim is given (*to investigate the magnetic fields around permanent magnets*). Apparatus are then listed. The method is then outlined. Results and observations are then given: *part A, the magnetic iron filings form a pattern that looks like the filings are round the magnet. The filings form a circle around the magnet. They move anti-clockwise. Most filings surround on the edge of each corner. Part B, the magnets attracts the arrows which causes them to move in a certain direction. The arrows form from the north pole direction to the south pole*. The conclusion is then given: *the magnetic filings take a s-shape. The arrows move from north to south then back north.* Diagrams of two magnets with lines around them are drawn at the end of the report
		PR1L2M	The name of the learner on top. Grade class follows and the date. The title experiment is followed. The aim of the experiment is given (*the aim is to see the direction of where was the magnetic)*. The apparatus are then listed. A diagram of a magnet with lines around it is then drawn. The method is then outlined. Results and observations are then given: *we saw where was the direction of the magnetic from N pole to S pole*. Interpretations of results then follows: *we saw the magnetic reaction of the direction from N pole to S pole*. A conclusion lastly follows: *we found out the reaction and the direction of the magnet*

		PR1L3M	The name of the learner on top. Grade class is give as well the statement physics magnetic field report. The title magnetic field of permanent magnet is given. The aim of the task is given (*to investigate the magnetic field around permanent magnets).* A list of apparatus is then given. Three diagrams of magnets with lines around them are then drawn. The method is then described. Results and observations are then given: *the iron filings bundle up by the S and N pole and the sides of the magnet only have a few filings*. The interpretation of results is also given: *the N and S pole attract a lot of filings because the filings must start from N and go to S then to N*. a conclusion lastly comes; *the iron filings go in a direction opposite the N and S to N again*
P2M	Instruction sheet		The instruction sheet has the heading portfolio practical 1. LO1: scientific inquiry and problem solving skills and AS1: conducting an investigation is also indicated. The aim of the task is given (an investigation to determine the period of a ticker timer). The instructions of how to conduct the task are given. Instruction number 5 indicates that : write a complete report of your experimental findings under the following headings: aim, apparatus, method/procedure, observation, results, interpretation of results and conclusion
	Learners practical reports (students worksheet)	PR2L1M	The name of the learner is given as well as the grade class. The heading laboratory report of experiment 1 is given. A number 1 is written with the following statement (*an investigation to determine the period of the ticker timer)*. Apparatus are then listed. The method is also described. Results are given in a table format. An interpretation of results heading follows: *some of the times are much longer than the other but not knowing why*. Then a conclusion follows: *we noticed that the frequency is very high in a short time*
		PR2L2M	The name of the learner and the grade class are given. The first is the calculation of the frequency and the period. The aim then follows (*to investigate and determine the period of a ticker timer).* The apparatus are then listed. The method is also then listed. The observation is recorded: *there are small blue dots on the tape.* The shape of the tape

			changed into a curly shape. Then the results are given in a tabular format. Thereafter the interpretation follows: *sometimes they are too far apart from each other (the* dots), then there are calculations of the period. Lastly the conclusion is given: *in the investigation we have noticed the frequency is very fast in such short time.*
		PR2L3M	The name of the learner and the grade are given. Then the calculations followed which were for frequency and period. Then the aim of the task is given (an *investigation to determine the period of a ticker timer).* Apparatus are then listed. The method is then described. Then the observation follows; *through my observation I observed that when the switch time is switched on the trolley rolls down and small little dots are printed every second and when the tape is finished the timer lets go of the tape and it rolls down.* Results are then given in a tabular form. The interpretation of results then follows; *some of the times are much longer than the others but not knowing why.* Then the conclusion: *we noticed that the frequency is very high in a short time.*
P1B	Instruction sheet		The name of the school is given at the top. Then the subheading portfolio practical. The grade and the mark total for the task are given. The total mark is 25. The first instruction indicates that *set up all apparatus as indicated below in order to investigate the current in and potential difference across each resistor when two or more resistors are arranged in parallel. Hence deduce formulae for equivalent values for resistance in parallel….* Apparatus to be used are then listed. An instruction is also given that between voltage and current they must indicated which one is independent or dependent with an explanation of the choice.
	Learners practical reports (students worksheet)	PR1L1B	The cover page has the learners name, topic, and names of group members, date and a table with skill areas listed and a grid for marks. A mark is also given. The grade is then given. The heading investigation is also given. The aim is given: *to know how much current in a potential across the resistors when three or less resistors arranged parallel.* Apparatus are then listed. Observations are given: set 1. *Was expecting the bulb to glow bright but it glow deamer. Set 2. Was expecting*

			that the two bulb was going to light the same but it second light bulb glow brighter than the first bulb. Results are also given: *It shows that the first light bulb was depending on the second light bulb because the second light bulb was getting more current than the first bulb*
		PR1L2B	The cover page has similar aspects as indicated in PR1L1B. The heading portfolio practical is given. The aim is given: *investigate the current in and potential difference across each resistor when two or more resistors are arranged in parallel. Hence deduce formulae for equivalent values for resistances in parallel.* Apparatus are listed. Circuit diagrams are then given. Observation is then listed. 1st set: *the light bulb is glowing bright. 2nd set: the second light bulb is glowing brighter than the first one. 3rd set: the third light bulb is glowing brighter than the first one but dimmer than the second one.* Results are then given; *the two last light bulbs are more brighter than the first one, even though the second one is more brighter than all.* The last aspect given was the conclusion; *current is dividing between the branches and what I think should happen is that the bulbs should all be glowing the same as their connected in parallel.*
		PR1L3B	The cover page has similar aspects as indicated in PR1L1B. The heading portfolio practical is given. The aim is then given: *investigate the current in and potential difference across each resistor when two or more resistors are arranged in parallel.* A list of apparatus is then given. The procedure with diagrams is also given. Observations are then listed: *1st set: the light bulbs was a little bright, 2nd set: there were two light bulbs and the second one was brighter than the first one. 3rd set; there were three light bulbs the first one was dim, the second and third one were brighter than the first one , they were the same with brightness.* Results are then given: *the more light bulbs you put in the electric circuit the more the brightness of the bulbs changes. Because the current divides itself to flow through the cells and the parallel bulbs, voltmeter are being used more.* Conclusion is also then given: *a parallel combination is current divider, each bulb gets the same current so they all glow the same brightness.*

P2B	Instruction sheet		The heading portfolio practical is given. Then the following instructions are listed. *Explain in your own words the meaning of titration. Hydrochloric acid neutralize sodium hydroxide in the experiment conducted in the laboratory. Write down the equation for the neutralization reaction. Design an experiment to investigate the neutralization of a base sodium hydroxide by acid hydrochloric acid.*
	Learners practical reports (students worksheet)	PR2L1B	The cover page has the name of the grade, learner's name, group members' names, date and a grid indicating the skills areas and the mark allocation. The aim is then given: *to determine the concentration of hydrochloric acid by using a standard solution of calcium carbonate.* Then the list of apparatus and chemicals used is given. The procedure is also given. Observations and results are then given followed by the analysis of results. A detailed conclusion is then given
		PR2L2B	The cover page has information as described in PR2L1B. The aim is given: *to determine the concentration of hydrochloric acid by using a standard solution of calcium carbonate.* A list of apparatus and chemicals to be used is then given. A diagram of the retort stand, burette and Erlenmeyer flask is given. Procedure is also then given. The observation and results are then given followed by the analysis of results. Detailed conclusion similar to PR2L1B. (According to the cover page they are not in the same group.)
		PR2L3B	The cover page has information as described in PR2L1B. The aim is given: *to determine the concentration of hydrochloric acid by using a standard solution of calcium carbonate*. List of apparatus and chemicals followed by a diagram of a retort stand, burette and Erlenmeyer flask are given. A procedure is given. Observation and results are then given followed by an analysis of results. A detailed conclusion similar to PR2L1B and PR2L2B was then given (according to the cover page they are not in the same group)

Key: P1M- means practical work 1 for teacher M

PR1L1M- means practical work report 1 for learner 1taught by teacher M

PR1L2M- means practical work report 1 for learner 2 taught by teacher M

PR1L3M- means practical work report 1 for learner 3 taught by teacher M

P2M- means practical work 2 for teacher M

PR2L1M- means practical work report 2 for learner 1 taught by teacher M

PR2L2M- means practical work report 2 for learner 2 taught by teacher M

PR2L3M- means practical work report 2 for learner 3 taught by teacher M

P1B- means practical work 1 for teacher B

PR1L1B- means practical work report 1 for learner 1 taught by teacher B

PR1L2B- means practical work report 1 for learner 2 taught by teacher B

PR1L3B- means practical work report 1 for learner 2 taught by teacher B

P2B- means practical work 2 for teacher B

PR2L1B- means practical work report 2 for learner 1 taught by teacher B

PR2L2B- means practical work report 2 for learner 2 taught by teacher B

PR2L3B- means practical work report 2 for learner 3 taught by teacher B

Appendix E: Coded official documents

CODE	TYPE OF DOCUMENT		CODE
P1M	Instruction sheet		HW,HE,TI,PA
	Learners practical reports (students worksheet)	PR1L1M	PP,HE
		PR1L2M	PP,HE
		PR1L3M	PP,HE
P2M	Instruction sheet		HO,HP,TV,PS,PP
	Learners practical reports (students worksheet)	PR2L1M	PS,TV,HP,PP
		PR2L2M	PS,TV,HP,PP
		PR2L3M	PS,TV,HP,PP
P1B	Instruction sheet		HR,PA,TV,HW
	Learners practical reports (students worksheet)	PR1L1B	HG,TV,HP
		PR1L2B	HG,TV,HP
		PR1L3B	HG,TV,HP
P2B	Instruction sheet		HR,HE,PS,TV,PP
	Learners practical reports (students worksheet)	PR2L1B	HG,HR,HE , HD
		PR2L2B	HG,HR,HE, HD
		PR2L3B	HG,HR,HE, HD

Refer to Tables 4.1, 4.3 and 4.5 for the description of the codes for column 4 in the table in Appendix E

Appendix F: Interview transcript of teacher B at Kwa Secondary School: 21/09/2007

LINE NO	Interview Transcript
1	**Q1: What is practical work?**
2	
3	**R:** Thank you very much for allowing me to come and interview you. Answer the questions to the
4	best of your ability. There is no wrong or right answer. And if there is something you did not get
5	right err you can just ask me I will clarify you. I am hoping that it will be 30 minutes long only.
6	The questions I am going to ask you fall into three categories of questions. The first one will be
7	about what practical work is, the purpose of practical work and how you conducted this practical
8	works. However this is not the weakest link quiz. The first categories of questions. Tell me a bit
9	about practical work.
10	**B**: Err thank you very much Mr. M. according to my understanding practical work is that
11	investigation that you engage learners into the investigation, practical something that they will do
12	themselves, they are involved in conducting that kind of practical work and they do a particular
13	research, not really a research they investigate but to investigate something they are given they
14	until they prove that particular thing. Right they see the results they observe what is happening,
15	they collect or gather the apparatus or chemicals and each one of them touch. They have a feel of
16	those particular results they were looking for. So that is basically what I understand about
17	practical work.
18	**R.** Thank you sir what type of practical work do you know?
19	**B:** Err like investigation err (long pause) research practical or project (so it is those two, the
20	investigation and then the project research)
21	**R**: Which kinds of practical do you prefer to conduct in class?
22	**B**: Investigation
23	**R:** Why investigations?
24	**B**: Err because it gives learners that chance to observe like by themselves to see like it gives them
25	that chance to see and observe what is going on in that practical and they do it themselves as a
26	group together they do their own investigations
27	**R:** What types of practical work have you conducted?
28	**B**: Err I think investigation like experiment, practical experiment, ya titration and the practical
29	experiment on electricity
30	**R**: So according to you the investigation and the experiment is it one and the same thing
31	**B**: Mmm not really because scientifically an experiment it something else and investigation is
32	something else, but in this one in my case I did both of them I did the experiment and the
33	investigation

34	**R**: If you were to explain practical work to somebody who does not know what would you say is
35	practical work?
36	**B**: Err you mean in terms of experiment and investigation (ya you can generalise or be specific to
37	investigation or experiment, R) in most cases when we do our learning we tend to focus more on
38	theoretical work that is done on the bookwork you read, so to someone who does not know about
39	this things I would explain the issue of practical in the sense of err you are now moving from
40	theoretical part and now you are getting to literal things and you see when you mix one two what
41	do you get as the results and that becomes a practical thing because it is something that you are
42	implementing the you are doing there and you are seeing there sometimes it had to get the wrong
43	results and you do it again until you get the right things because you see in like if I can talk in
44	term of types education like we use to learn about like in the Bantu education where we used to
45	learn about locust you know you don't know what is going on you only learn theoretical about it
46	when it comes to practicals this is where you see exactly what is going on you don't learn
47	theoretical.
48	**Q2: Purpose of practical work**
49	**R** What is the purpose of practical work?
50	**B**: Exposing learners to the, err meaningful learning to allow learners to move from theory to
51	reality of learning. Because when we bring the concept of practical now it becomes something
52	that has to do with them knowing and doing a thing, it is a verb doing something. It is not
53	something that is being done by someone and writes a book about it. So themselves they learn
54	more about that particular thing
55	**R** What was the purpose of the practical work you have conducted?
56	**B**: In this one for instance (the one for acid) you see I can give an example of somebody who has
57	a stomach bug. Whose stomach has become so basisic or acidic you know exceeding 1 in the ph.
58	You find that because of that the digestion is disturbed and the stomach is irritated. Then in that
59	case I explain to my learners that you need to neutralize if you want to be healed in that stomach
60	bug. You need something to neutralize that acid which is strong in your stomach. So you need a
61	strong base to neutralize that. So they said how. I said let us conduct an experiment called titration
62	to check whether this two things can neutralize each other. So by conducting that experiment I
63	was able to allow my learners to understand more in the real world to say the strong acid can be
64	able to neutralize the strong base. So that was the main purpose that I was teaching them (the
65	other one you said it is about electricity, what was the purpose of that one, R) we were to
66	investigate the current and potential difference across resistor when two or more resistors are
67	connected in parallel because in most cases learners they would confuse parallel connection and
68	series connection and the effect of parallel we wanted to investigate that. So this was more of an
69	investigation were we wanted to check on like when we temper with the resistors so the resistance
70	we are tampering with the current so it becomes independent and the dependency from the

voltage. We wanted to investigate that more (so which means the first one of titration it was more of an experiment and this one for electricity was more of an investigation) yes

R: Comment on the suggestion that practical work can be used to explain laws and theories of physical science

B: Yes we can use the practicals or investigations to investigate particular laws that have been passed because when you talk about laws we start from theories that have been placed by these particular people for a number of decades or years. Then when it passes particular years it becomes a law. If it has not been challenged so I use to explain that we as science learners we are able to investigate that particular law using practical. So we can use a practical to get deeper into that particular theory that has been written by someone and … (he indicated that practical work can be used to prove or indicate a particular law…)

R: Comment on the suggestion that practical work can be used to develop process skills

B: Yes you are right on that one I agree with that fact because when we deal with process skills it is a continuous doing of something that is a process from the first stage second until you finish that particular process. So when we deal with practical we are actually showing learners to say you don't just emerge and get a result you need to follow a particular process and in order to arrive to a conclusion of something. That particular process skills can be satisfied can actually be enhanced if we follow a particular practical and that we will do over a given time to say we are moving from A to get to B that we lead us to C.

R: From this experiments that you deed what are some of the example of the process skills which you were targeting that they must develop?

B: I started by saying to my learners that we need to collect certain information from point a, we collected data to say we are starting from there. And then after collecting the data let us use that collected data to implementation to apply that collected data. And after applying data we can still analyse that particular data and do some calculations until we arrive to particular conclusion so those were the process skills that I followed.

R: What does the assessment guideline say about the purpose of practical work?

B: In assessment guideline (long pause) they explain the issue of group work and rubric to assess that particular practical, to say learners have used these skill areas and from group work skill to write up skill to procedural skill to observation, and measurement skill to recording of that data and to interpretation of that data until you conclude. So in that assessment guideline they advise that when we assess and score we must score them based on the skill areas. We look at the skill areas and we score them. (Did they say anything like this is the purpose specifically of practical work or may be it is not explicit in the guideline) it is not unless if I did not go through it nicely but I understood that it was not clear (but you have seen the assessment guideline) ja

R: When you conduct your practicals do you link the purpose with the type of practical work

B: In a way but not in reality that I have say I have sat down and looked at those because my

situation it was very difficult for me because even the assessment guideline I got it difficult…. So it was difficult but hopefully next year I would be able to implement the guideline thoroughly. (In other words you are saying when you were conducting these practicals you did not say this is the purpose like the acid can neutralize hence an experiment will be the type of practical. Do you think about the purpose and then choose the experiment, R) that is why I am saying in a way I have looked into it but not in detail but in passing when I gave them a practical overview, when I link with them interact with them looking at the baseline of their pre knowledge to acids and bases so I have actually highlighted some of those things that in asking them what do you think will happen.

Q3. **The next questions will be on how you conducted practical work**

R: When your learners perform practical work what outcomes do you want them to achieve

B: What I basically want is different actually because in this outcome of this NCS they outlined three of them like wish that my learners enhance their scientific knowledge and ….. Again I will just look at the outcome number 1, I will expect my learners to know I and 3 that will be the application of the things that they have done. All of the three outcomes actually I want them to be satisfied from that particular practical

R: Did you achieve the learning outcomes you were intending to?

B: Definitely I think so (may you please elaborate on that, R) err my learners were able to work in groups and I wanted to enhance their writing up skills and my learners were able to work neatly and they presented table and they suggested headings and they worked systematically and the graphs that they used were ok and following procedures learners were able to follow procedures like aims list of apparatus and results observation and so on and when it comes to interpretation of data learners did correctly write the explanation and they interpreted using the table of results and so on so I was able to achieve what I was looking for in that practical

R. What were the outcomes of your practical work? These practicals specifically

B: According to the guideline, rubric they always give us the skills areas which in a way according to me they become the, because you want your learners to enhance a particular skill area. So according to me that will become your outcome because when you do like for instance when you start in this practical I wanted to check if my learners will work in groups. So that was my outcome I wanted to check on

R. How many practical work tasks did your learners perform this year?

B: They did about 6

R Why did they perform six?

B: as requested in the guideline that they should do two. (any reason why six, AV) it was simply exposing them and it gave me a variety of choice to say I will choose this two after doing the practicals and I think it assisted me in a way to make them understand the subject content more

R If you were to change the way you conducted practical work, what would you change?

145	**B**: I would look at goals more and explaining better before we start with each practical I will look
146	at my objectives and explain them. I think that area I needed to have been exposed that much and
147	I explained it better
148	**R**: How did your ideas of practical work influence how this practical works were conducted?
149	**B**: Err actually mina I believe that a practical should be at an atmosphere that will be interesting
150	and should be created and when we did this practicals titration I was able to create that particular
151	atmosphere and it came as an idea and I have influenced them to understand and to be fully
152	involved in that particular practical so that is why I have managed to use my influence in relation
153	to this experiment (what you are telling me is that your ideas of practical work is what is
154	manifested when they do practical, R) yes exactly
155	**R:** Do you have anything to say about practical work
156	**B**: JA I think the last question should be in a way helpful because what I know about practical will
157	basically be what my learners know about practical. Meaning I as the teacher needs to know better
158	so that my learners can know better about it
159	**R:** Did apparatus influence how you conducted these practicals?
160	**B**: It does,
161	**R:** How did it affect you?
162	**B:** err not that much, I have the fully equipped laboratory (but the lack of laboratory assistant
163	makes him not to do many practicals)
164	**R.** thank you very much

Appendix G: Summaries of typologies for teacher B

LINE NO.	Summary of the typology: What practical work is and types of practical work for teacher: B	CODE
1	- practical work is an investigation where you engage learners until they	WS
2	have proven a particular thing	
3	- types of practical work , investigation and research practical	TV,TDC
4	- prefers to conduct investigations	TV
5	- has conducted investigations and practical experiment	TV,TDC
6	- investigation is not an experiment	TV
7	- practical work is when you move from theoretical and get to literal things	PS,WDC
8	- something that you do until you get the things right	WDC

LINE NO.	Summary of the typology: purpose of practical work for teacher: B	category
1	- to observe what is happening, collect apparatus and feel them	PP
2	- to give learners a chance to observe by themselves as a group	PP
3	- to see exactly what is going on you do not learn theoretical	PP
4	- to expose learners to meaningful learning	PS
5	- to allow learners to move from theory to reality of learning	PS
6	- for learners to know and do	PS,PP
7	- to learn more about a particular thing	PS
8	- to allow learners to understand more in the real world	PDC
9	- to enhance the understanding of parallel and series connection	PS
10	- to investigate particular laws	PS
11	- use practical to get deeper into a theory	PS
12	- to prove or indicate a particular law	PS
13	- collect , analyse data and reach conclusion	PP
14	- after long pause assessment guideline say nothing about the purpose of	HG
15	practical work but only about group work skill and rubrics	
16	- to enhance the scientific knowledge of learners	PS
17	- to be satisfied	PE
18	- to be able to work in groups	PG
19	- to enhance their writing up skills	PP
20	- to follow procedures	PP
21	- to check if learners can work in groups	PG
22	- to enable learners to understand the subject content more	PS

LINE NO.	Summary of the typology: how practical work was conducted for teacher: B	code
1	- I can give an example of somebody who has a stomach bug (stating point of the	HE
2	acid base experiment)	
3	- In a way but not in reality that I have say I have sat down and looked at those	HR
4	because my situation it was very difficult for me because even the assessment	
5	guideline I got it difficult	
6	- I conducted the number as per the requirements of the assessment guideline	HR
7	- I would look at goals more and explaining better before we start with each	HR
8	practical I will look at my objectives and explain them. I think that area I needed	
9	to have been exposed that much and I explained it better	
10	- Practical work should be at an atmosphere that will be interesting	PE
11	- What I know about practical will basically be what my learners know about	HR
12	practical. Meaning I as the teacher needs to know better so that my learners can	
13	know better about it	
14	- Apparatus did not affect me that much because I have a well equipped laboratory	HA
15	but the lack of laboratory assistant makes me not to do many practicals	
16	- Assessment guideline say two pracs must be done	HR
17	- Did six to expose them and a pool to choose the two for the department	HR

Appendix H: Interview transcript for teacher M at Zzz School 19 September 2007

LINE NO.	Interview Transcript
1	**Q1: What is practical work?**
2	**R**: Thank you very much sir for allowing me to come and interview you. I am going to ask you a
3	few questions based on the practical work you have done and then your knowledge of practical
4	work. Feel free to answer it the way you want. Express yourself the way you want. Relax. You are
5	relaxed isn't sir. I am going to ask you three categories of questions. The first one will be what
6	practical work is, and the second one the purpose of practical work and the third one will be
7	questions on how you conducted practical work. Now, the first category of questions on what
8	practical work is. Now can you tell me a bit about practical work?
9	**M**: Practical work as it says practical is something that they do it by themselves. Eh they use
10	equipment which we call them apparatus and then to prove or to reinforce what they have learnt in
11	class. So practical work I will take it that way. It is when they are using apparatus and equipments
12	to reinforce what they have learnt during the lesson or sometimes you can use it. It depend which
13	method you are either using deductive or inductive method. So you can start with the practical so
14	that you can explain some concepts or you start with the concepts and use practical to explain it.
15	**R:** The next questions. What types of practical work do you know?
16	**M**: What type of ... (Practical work do you know, R) do I know (mm what types of practical work,
17	R) what do you mean by type of practical (mmm let us say there is a demonstrative practical
18	work, R) oh group work, demonstrations. Ja because group work, demonstrations and what else,
19	those two if I can remember
20	**R**: Which kinds of practical work do you prefer to conduct in class?
21	**M**: It depends with the type of equipment you are using. Because you cannot use micro kit to
22	demonstrate. Learners they cannot see. But you eee. There are times were you find… the other
23	thing what controls you if you have got enough apparatus then you can ask the group to do it but
24	you do not have enough apparatus you can do demonstration. The other reason is sometimes you
25	give them practical work they tend not to focus on something you want them to focus on. So if
26	you demonstrate you know exactly what you want them to see. So demonstration sometimes they
27	help a lot they do not mislead learners but in group work sometimes some group will work some
28	group will not. But the advantage with group work is that they learn by themselves. I mean it is
29	self discovery they discover things by them selves without being led by the teacher.(so which
30	means in other way you prefer demonstration more, because of the reasons you have indicated, R)
31	I think it work together because one if you demonstrate it they do not get the feeling of that thing
32	they do not get the feeling that they did it by themselves but the best thing is to minimise group,
33	have a group of two to three but if you have a group of five to eight then it becomes a problem.
34	But if it is about three in a group then they work very nicely but you can start by demonstrating

for them let say you have a double lesson, spend 10 minutes just showing them how they are going to do it. And then you ask them to do it by themselves, in that way ee they learn better, because if you just demonstrate things for them then sometimes, lets say you talk about solenoid, they can see those coil, but they are not sure weather it is a coil or really it is something that is just metal plate but if they can touch they know it they feel it. So the best thing in a group work is two to three is fine more than that it start to be chaotic.

R: What are the types of practical work you have conducted so far?

M: I have been doing physics practical with them (where they for example demonstrative or group work, R) both demonstrative and group work, that is how I do it. Every prac that I am going to ask them to do it, first I demonstrate it to them but there are times that I just give them the work sheet and tell them that follow the instructions and then they do it for themselves. But most of the case I start with demonstration so that they know what they have to do.

R: This might like it is repeating but it is not. If you have to explain to somebody who does not know anything about practical work what would you say?

M: Practical work. I would say it is …. When the learners are not using pen and paper but they are using apparatus to learn some concepts.

Q2: Purpose of practical work

R: According to you what is the purpose of practical work?

M: The first… the reasons most learners they love science because it is fun .Practical work it is fun. It is entertaining to them because if you teach and don't do practical work they don't enjoy it. That is one of the reasons the second reason it is to make them understand some concepts better. Ee you must understand you have got different people in the classroom some of them they can learn by rote learning reading the notes. Some they can learn by doing things for themselves. And you notice most of the science learners they love to do things, that is why they do science so if you don't do practical work, you miss those learners.

R: So based on these two practical works, what were the purposes of these practical works that you conducted?

M: Ye the first one electricity and magnetism, this one it is to show that in a bar magnet there are magnetic fields. I started by showing them… obvious they know that any magnet it is magnetic and but then how do they see those magnetic field lines, if you put the iron filings they can see the lining up of the iron filings but then the next thing with the first demonstration which … in fact this they did it themselves. Now they can put the iron filings and they can see the iron filings lining up around the magnet. But then it does not indicate the direction of the field lines this. So they can see that they are magnetic field lines around them but to which direction north and south you start to use compass like in the second figure , then the compasses they line up to the direction north to south. So they can see they are moving from north to south. So this thing you can teach them theoretically it can be a one lesson but if you do it practically it can take two

lessons because they have to do this and they will see all of these things. Err the iron filings lining up and using the compasses seeing the n and s pole. It was very interesting for me I did this on the overhead projector. I put this over the projector. You must understand the problem with science demonstration especially with this you must have a laboratory assistant, because if you do not have laboratory assistant you must to be creative so that you do not need somebody who is going to clean after you.

R: Can you comment on the suggestion that practical work can be used to explain laws and theories of physical science

M: Ja can I comment on that (ja, R) now the problem is like lets take for instance, like this one we tell them that field lines are imaginary lines, and meaning that it is something that is not there. But they can experience it like for instance magnet and magnet……but if you draw it on the board they think that any bar magnet if you just draw it they will think any bar magnet will have those but then give them a bar magnet like this one they don't see those things. So then using the iron filings here it shows the pattern here they can see the pattern then they get to understand that. So now because they have seen it practically they will be definitely sure that there is something like this because they have seen it, they will never forget it, every time you talk about a bar magnet , like now they always have a picture of that thing on the overhead projector. So every time you are asking them about magnetic field lines they will always think about the overhead projector somebody demonstrating with it, but if you write it on the board, at the end of the year they have got so much notes they tend to forget,

R: The next aspect, would you comment on the suggestion that practical work can be used to develop process skills

M: Hey (can be used to develop process skills form example, observation skills, R). hey ja, interpretation skills, observation, analysing because those skills you will get it back when they are doing their laboratory reports, because after they have done everything, they have to present it to you, explain it to you, what does it mean, that is the problem they can have fun, like with the chemistry practicals, they will have lot of fun but not understanding exactly what is happening explaining some of the things. So some learners that is were the teacher has to get in because now you have to explain why this things are happening like this and they also have to be able to write , take what they see and interpret it, it is like teaching circuits you teach them light bulbs, now you have got a circuit board in front of you take what you see and draw it on a piece of paper, so translation from what they are observation and being able to explain it to someone else who can read, that is why I always tell them when they are writing especially the method part. Now explain to me how you did the report, now when they write the method they must write it as if they are explaining to me so that I can be able to do that experiment as if I was not in here. So they should be able to read results, interpret results and be able to draw conclusion from the whatever they were doing (so which means, in other words you are saying that let say may be you give them a

circuit board , how to build the circuit board, R) they have to build the circuit board (that is also may be a skill they can develop, R) you teach them how to build a circuit board, you show them how to build a circuit board, but from the circuit board now using circuit symbols, they saw a light bulb, a resistor, they saw an ammeter , now you take what you have seen there and the reverse again you give them a circuit diagram and ask them construct this circuit. That is what I did with some. Give them two resistors in series, three light bulbs in parallel then they got a sheet then you tell them construct the circuit board. Reading to doing and putting it into reality

R: What does the assessment guideline say about the purpose of practical work?

M: Eee (long pause) the assessment obvious you are looking at group work. Everyone is participating in the group work. You are looking at interpretation of results where they able to interpret the results and then it depend and you also looking at. Obvious you always ask them for the laboratory report after that. But for me most interesting when they do practical work I want to see what they were doing did it work, if it didn't work why it did not work. And I always encourage them in their conclusion. This happened and this didn't happen because of this. The other problem with practical work they tend to copy each other's work. If one group is doing this and they have got that. You will find that one person keeps walking around to find out what others did and tell the others.

R: Do you link the purpose with the type of practical work you want to do?

M: Do I link the purpose of the … What? Experiment (JA, with the type of practical work lets us say if it is a demonstration. Err do you have a particular purpose in mind when you decide how you are going to do a practical work, R) do I choose how I am going to do the practical work (do you link the purpose with the type of practical work) what is the purpose of doing this practical work (ja do you link that with the type of practical work you are going to do, let us say group or demonstration) may be what controls me to do demonstration or group work quite often. Firstly it is do I have enough equipment and secondly it is the type of class you are working with. There is a type of class that you know that if I give this class, they will work but if you have got a very big number of classes and uncontrollable you can't just give them apparatus to work with them. So the best thing is because your aim you want them to learn after all you are only interested in that not that they have fun.

Q3: **How you conducted practical work**

R: When your learners perform practical work what outcomes do you want them to achieve?

M: Ok firstly obvious they appreciate things. Err and also there is this thing in working together, there is this thing of belonging, they appreciate what they have done. Quite often because they know that that work was done by them. Not by the teacher and secondly there is that sense of belonging if somebody is working with a group , she feels that she is not only by herself I am saying she because I have got girls only. So she feels that I did something because you will notice that if there is a clever girl amongst themselves they always run around her. So that is why it is

always advisable that you always spread them. Distribute them so that in a group there is one girl who is a bit clever. Or you feel that a she has got that leadership potential. So they appreciate and respect for one another and obvious the sense of belonging. Those are the things that are quite during in the lesson when they are doing group work

R: Now did you achieve the learning outcomes you were intending to in these practicals that you conducted

M: Iya in fact not with this one like I told you I demonstrated, because now the danger with this if you do if you let them work in groups you lose compasses and they mess up with iron filings. So they play around with the magnets they love playing around. Before they can do what they are asked to do, this are grade 10 is unlike grade 12 they will mess up and play and at the end of the day they won't do what you want them to do. But with the ticker timer definitely it worked very nice. Because all they are worried with is how to find the frequency, how to find the frequency how to find the time. So this you can do it depend with the type of experiment you are working with and what you want to achieve

R: So in other words what were the outcomes of the practical work for example that one which you say it was not demonstration

M: This one I just explained to them what they had to do they did it themselves get the ticker timer, put the tapes, time it when it is running down the trolley and then working out, so they learn how to use the stopwatches again once I am teaching because they have to learn how a stop watch and then setting up, they had to set up everything themselves. I don't do it they go through this it has instructions. Finally it is a simple thing here aim is to work out the period. Now I can teach them this formula here in one lesson but if they do it themselves it is much better for them. So it worked very nice. Here is a problem if you demonstrate this one for them it won't be as interesting as this one. Because here they will just be looking not knowing exactly understanding what is happening. But this one they love to do it, it is unfortunate thing girls when they come to some of the things they are not very keen about this they are keen about this type of experiment

R: How many practical work tasks did your learner perform this year?

M: Practical work tasks for this grade 10 yo… how many I think 4 or 5.

R: Why did your learners perform the number of practical work tasks you have indicated?

M: He (why the number of practicals, AV) ya what I am doing is I what I normally do firstly for a every section I try by all means to do at list one practical work, either by demonstration or group work. So the reason is because I think I have got 5 or 6, I did the waves, and this was electromagnetism. This was motions. Like were they work out frequency time and they had one again for electrostatics and electricity. At least u can't do all of them I just take one which is the core which is the central one where I am going to build my lesson

R: Now if you were to change the way you conducted the practical work, what would you change?

183	**M**: err … You see the one with the ticker timer, let me start with this one obvious it needs more
184	control for them to do it, you need more control if you want them to do it. Other than
185	demonstrating it but the problem with this I find if I am demonstrating with it at least they can
186	focus on what is happening. And then this none of the ticker timer if I am looking at this here they
187	did this one in one period and they finished before it ended, I have a very good class of grade 10.
188	here I notice it says practical one err to determine the period of the ticker timer, more than the
189	doing of the experiment itself they were busy constructing like putting the tape and the ticker
190	timer after that within 10 minutes they were finishing. And they were writing the laboratory
191	reports so what I normally prefer I prefer whereby after this they calculate the velocity. So they do
192	those two practicals in class but what I normally do they do everything in class take the results
193	they go write the report and the next day they bring me the laboratory report. Because it is neatly
194	written and they can clearly explain and they can relate what was happening in the classroom and
195	using their books (so which means if you were to change the way this was done it will be the time,
196	R) it is the time I can change in fact this is the second time I am doing this last year I did this with
197	the grade 10 it was one day one lesson they did this the next the other one. So what changed this
198	year is that I did two pracs in one day with them. So it means that it is the time I can change,
199	which I have changed.
200	**R**: Now the last question now how did your ideas of practical work influence how the practical
201	was conducted
202	**M**: Mmm, how did the ideas (your ideas influence, AV) my ideas (yes influence how this
203	practical work were conducted, AV) err, obvious every time when they do practical work there is
204	something new you learn from them. You notice, like for instance you think that they know how
205	to draw tables and only to find that they do not and you end up teaching Maths in a science lesson
206	where you teach them graphs. I always say this is not a Maths lesson. So that is why first term I
207	do chemistry and last term physics because in physics they have a good background of foundation
208	of Maths by then. So some of the things they can do it by themselves (so which means you are
209	telling me that your ideas of what practical work is influences how you what your learners to
210	conduct practical work in class, R) ya how it is done in class (because) ja in fact there a problem
211	with practical work because you wont know exactly what they are going to do, you can come up
212	with your own idea that this is how I am going to do with them and then end up doing differently.
213	So you just have to be flexible and be aware every time of how and what they are doing. So if you
214	stick this is how they should do it because some groups you can explain to them verbally without
215	giving them a worksheet they can understand exactly what you want them to do but some learners
216	you need to give them instruction sheet step by step of how to do it.
217	**R**. So thank you very much

Appendix I: Summaries of typologies for teacher M

LINE NO.	Summary of the typology: What practical work is and types of practical work for teacher: M	code
1	- practical work is that which learners do by themselves using apparatus to	WI
2	reinforce what they have learnt in class	
3	- It is when they are using apparatus and equipments to reinforce what they	WI
4	have learnt in class	
5	- Types of practical work are group work and demonstration	TO
6	- So if you demonstrate you know exactly what you want them to see	TO,WT
7	- demonstration sometimes they help a lot they do not mislead learners but in	WT
8	group work sometimes some group will work some group will not	
9	- advantage with group work is that they learn by themselves	WG
10	- they discover things by themselves without being led by the teacher	WH
11	- it work together because one if you demonstrate it they do not get the feeling	HD,HG
12	- you can start by demonstrating for them (for group work)	
13	- And then you ask them to do it by themselves,	HD
14	- The teacher had been doing both demonstration and group work	WH
15	- In general practical work is When the learners are not using pen and paper	HD,HG
16	but they are using apparatus to learn some concepts	WI
17	- Practical work is fun	PE
18	- He does demonstrations	TO,WT
19	- They know that that work was done by them. Not by the teacher	WG
20	- practical work is when they do it by themselves	WG

LINE NO.	Summary of the typology: purpose of practical work for teacher: M	code
1	- to explain concepts	PS
2	- to let learner have a feel of doing it by themselves	PM
3	- to enable learners to touch and feel	PM
4	- it is fun	PE
5	- to entertain	PE
6	- for enjoyment	PE
7	- to make them understand some concepts better	PS
8	- to cater for different learners as some learn by doing	PD
9	- learners do science because they want to do practical work	PM
10	- they see pattern made by iron filling s they get to understand field lines	PS
11	- because they have seen it they will never forget	PS
12	- to develop interpretative, observation and analysing skills	PP

13	-	to take what they see and interpret	PP
14	-	So they should be able to read results, interpret results and be able to draw	PP
15		conclusion from the whatever they were doing	
16	-	Show them how to build a circuit board	PP
17	-	Give them a circuit diagram and ask them to construct it	PP
18	-	Reading to doing and putting it into reality	PS,PP
19	-	To participate in a group	PG
20	-	To interpret results	PP
21	-	To appreciate things	PM
22	-	To work together and develop a sense of belonging	PG
23	-	To develop respect for one another	PG
24	-	Learn how to use stop watches	PP
25	-	Learn how to set up a practical	PP
26	-	To build a lesson	PS
27	-	To learn from them	PM

Line NO.	**Summary of the typology: how practical work was conducted teacher: m**		**category**
1	-	depends on the type of equipments	HA
2	-	depends on the availability of apparatus (type of prac)	HA
3	-	you give them practical work they tend not to focus on something you want	HD
4		them to focus on (why demonstration)	
5	-	minimise the number of learners in a group to avoid problems	HG
6	-	in a group spend 10 minutes demonstrating and then allow them to do as a	HD
7		group	
8	-	every prac I demonstrate to them	HD
9	-	sometimes I just give them instruction sheet and tell them to follow the	HW
10		instructions	
11	-	I start with demonstration so that know what they have to do	HD
12	-	I started by showing them. ..infect they did this themselves (iron filings)	HD
13	-	It was very interesting for me I did this over the overhead projector	HD
14	-	I do demonstrations because you must have a laboratory assistant to clean	HD,HA
15		after you	HN
16	-	Problem with practical work they tend to copy each other's work	HA
17	-	What controls me to do demonstration or group work is do I have enough	
18		apparatus	HN
19	-	The type of class you are working with	HN

20	-	If the class is uncontrollable you cannot just give them apparatus to work	
21		with	HN
22	-	if you let them work in groups you loose compasses and they mess up with	
23		iron filings	HO
24	-	it depends with the type of the experiment and what you want to achieve	HM
25	-	ticket timer they did by themselves	HE
26	-	every section I do at list one practical	HE
27	-	At list u can't do all of them I just take one which is the core which is the	
28		central one where	HD
29	-	I demonstrate so that they can focus	HR
30	-	I ask them to write laboratory reports at home because they are neatly done	
31		and well explained	HN
32	-	only to find that they do not and you end up teaching Maths in a science	
33		lesson where you teach them graphs	PD
34	-	some learners can work by themselves so you have to be flexible others	
35		cannot work by themselves they need written instructions, step by step of	
		how to do it	