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PHYSICAL SCIENCE TEACHER'S PERSPECTIVES OF THE TYPES AND NATURE OF PRACTICAL WORK

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Abstract. *This is an empirical qualitative interpretative multiple case study, which was guided by the question; what are the teacher's perspectives of the types and nature of practical work? Document analysis and interviews were used for data collection. The results show firstly, that teachers held faulty perceptions of the nature of practical work. Secondly, the teachers' individual definition of practical work contradicted their own perceptions of the nature of practical work. The faulty perceptions held by teachers influence outcome of the practical work to such an extent that some output only result through chance. Explanations and possibilities for the resultant perceptions are discussed. This paper recommends that science clubs and cluster group collaborations might aid methodological and contextual understandings and practices amongst teachers. Further research opportunities on ways and strategies of conducing practical work within contextual inhibitors are suggested.*

Key words: *contextual inhibitors, practical work, procedural understanding, substantive understanding, teacher perception.*

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Introduction

What are the teacher's perspectives of the types and nature of practical work? Many studies in South Africa, for example (Ramnarain, 2014; Motlhabane, 2013; Dudu and Vhurumuku, 2012 and Stoffels, 2005) have been undertaken focusing on practical work in physical science, amongst others, looking at what teachers do in the classroom during practical work or the challenges they continuously face. Ramnarain (2014) posits that some physical science teachers in South Africa were of the view that physical science practical work is for making the subject of physical science enjoyable and development of students' experimental skills. As such, physical science teachers do not view practical work as a basis for the development of substantive understanding of concepts in the subject of physical science. Ramnarain (2014) further elaborated that some physical science teachers believe that their explanations are better than when they are conducting a practical work to enhance the comprehension of concepts by students. They apportion this blame on the lack of apparatus and other contextual factors like overcrowded classrooms. In addition, Dudu and Vhurumuku (2012) also attest to the fact that teachers' focus when teaching science is on the mastery of the subject matter than practical work. However, Motlhabane (2013) indicated that teachers doubt the usefulness of practical work in the content comprehension. Therefore, it will be futile exercise to attempt to assist teachers without first ascertaining their perceptions on practical work. This is so because Tobin (1988) has shown that it is utterly difficult to change the teacher's schemata of what works and what does not work. So, in an endeavour to show teacher's other ways and reasons of using practical work it is therefore essential that their perceptions are qualitatively emancipated.

In addition, according to the Department of Basic Education (DBE, 2011: 11) "Practical work must be integrated with theory to strengthen the concepts being taught. These may take the form of simple practical demonstrations or even an experiment or practical investigation". This is the resolute focus of the revised curriculum, Curriculum and Assessment Policy Statement (CAPS) on the status of practical work. The DBE (2011) further prescribes that students should at least do one practical activity

per school term. The South African schooling period has four terms and one term is approximately eight to nine weeks. The question emanating from this is therefore, does the wish or policy statement of the DBE translates into fair implementation? Posits from research have shown that it is not (Ramnarain, 2014; Motlhabane, 2013; Dudu and Vhurumuku, 2012). As such, it is rational to interrogate the resources that are receptive of these polices, of which in this paper; it will be the teacher's perceptions on practical work and its types. With this emancipation, more thought process and constructive ideas in assisting practicing teachers in seeing the importance of practical work in augmenting substantive comprehension of science concepts should be realised. Rogan and Grayson (2003) propose that it is important to acknowledge the present situation in schools in order to build innovative approaches that should assist teachers better. As such this paper will attempt to illustrate teacher's views of the types and nature of practical work to build a case for informed continuous teacher development in conducting practical work.

In investigating the perceptions on the nature of practical work it is imperative that one situates the nature of practical work and its definition from literature. There are many definitions and explanations of what practical work is from the literature. The DBE (2011) describes practical work as all activities that can be used to develop process skills as well as substantive comprehension of the content. As such the definition of the DBE is not confined to a classroom or laboratory. It is also emphasised that it must be integrated into theory than to be performed independently. Yet, Tsai (2003: 847) indicates that "practical work in school science means laboratory-based experience". The problem with this kind of view is that it limits the activity into the laboratory which is not always true, especially in the world of micro kits. Stoffels (2005) indicate that practical work refers to those teaching and learning situations that offer students opportunities to practice the process of investigation. He further indicates that "this would involve hands-on or mind-on practical learning opportunities where students 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. This view is very broad and encompasses all activities that are laboratory confined as well as those outside the laboratory, either under a tree or a mud classroom. The usage of micro-kits facilitates this as well. Kask and Rannikmäe (2006: 6) indicate that "inquiry based experimental work develops students' process skills". This impression 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. Yet, the emphasis from this perspective is on the development of skills than also encompassing the comprehension of science concepts.

Millar, Le Maréchal and Tiberghien (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. Consequently, no parameters can be used to indicate what practical work is. Anything that students are studying and they can observe or lay their hands on can be called practical work according to this definition. Donnelly (1998: 588) postulates that "practical work usually means individual or small-group pupil laboratory work. It does not commonly refer to teacher demonstration". According to Pekmez *et al*. (2005) practical work can be defined from the perspective of the movements influencing it. The discovery learning movement exemplifies practical work as the means for discovery learning wherein students develop their thinking. The process approach movement describes practical work as the methodology that will give opportunities to students 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 "students have to be thinking about what lies behind what they are doing rather than simply applying a practiced process" (Pekmez *et al*. 2005: 11). 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 denotes process skills and substantive understanding refers to the understanding of concepts laws and theories (Pekmez *et al*., 2005). It is worth noting that there is a similarity between the process approach movement and the investigation movement on what practical work entails. 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. Therefore, according to the investigation movement practical work is the approach to teaching and learning that will enable students 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 students' need to understand as well as the process skills they have to practice and develop with the ultimate aim of developing problem solving skills.

As the research has shown that there are various ways in which practical work is defined or conceptualised, this is also true with various types of practical work. The DBE (2011) identifies practical work as follows:

- Practical activities refer to practical demonstrations, experiments or projects used to strengthen the concepts being taught
- Experiment refers to a set of outlined instructions for learners to follow in order to obtain results to verify established theory
- Practical investigations will require learners to go through the scientific process

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

- Demonstrations that verify facts and principles
- Repetition by pupils of standard qualitative experiments, e.g. 'to show that…'
- Repetition by pupils of standard quantitative experiments, e.g. measurement of physical constants
- Fundamental classical experiments repeated to show crucial stages in the logical development of a principle or topic
- Problem-solving or discovery experiments (by teacher or pupil) designed to answer a question raised in the development of the theoretical work
- Investigation projects- problems worked out by the pupil(s); not necessarily connected in direct way with theoretical course
- 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. Kapenda *et al*. (2002:54) identifies five types of practical work which are:

- Exercises to develop specific skills
- Investigations including hypothesis testing or problem solving
- Experiments to introduce students to particular phenomena
- Demonstrations to allow the teacher to develop a scientific argument or create a dramatic impression
- Fieldwork

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. However, not all types of practical work develop the students in their planning and execution of the work. Kask and Rannikmäe (2006) refer to these as cookbook recipe experiments that do not develop planning skills.

Methodology of Research

General Background of Research

This was an empirical qualitative interpretative multiple case study, which was conducted in the Gauteng province in South Africa and focused on an in-depth analysis of teacher's perceptions of the nature and types of practical work. The aim was not to generalise, but to comprehend the perceptions of these teachers and make inferences thereof.

Sampling

It was a comprehensive purposeful sampling of two cases. As resources can influence how a teacher teaches (Rogan and Grayson, 2003) it was ensured that cases chosen were in schools that had adequate resources to facilitate practical work. This was to eliminate the lack of apparatus and other resources needed for practical work as a reason by the teacher to conduct practical work in a particular way. The teachers selected also had to be qualified with at least a teaching diploma and a minimum of two years teaching experience in the current school at the time of data collection. This was necessary because teacher's qualifications and confidence with the context can influence how teaching occurs.

The Cases

The two cases in the study will be called Teacher Mpho and Teacher Bugana. Teacher Mpho taught at a former Model C school. A former Model C school is that which was more resourced than many schools which were found in the townships. His highest qualification was an honours degree in science education. His school was well resourced and they had a laboratory. The class had about thirty five students. Teacher Mpho had been teaching for at least fifteen years of which the last 6 were in the present school. Teacher Bugana whose highest qualification was a secondary teacher's diploma (STD) taught at a school which was situated in a township for five years. Township refers to the often underdeveloped urban living areas built on the periphery of towns and cities that, from the late nineteenth century until the end of Apartheid, were reserved for non-Whites. The school was under resourced even though there was a laboratory room it was not equipped. The school was fairly new in the area and overcrowded. Teacher Bugana's class had about seventy three students. The teachers were chosen from these different environments to also check the influence of students' numbers and resources on the perceptions.

Instrument and Procedures

Interviews and official documents were used to collect data for the study. Two types of documents were collected from each teacher, which was the students' practical work task reports as well as the instruction sheet from the teacher. After analysing the documents, teachers were interviewed. The focus of the questions was on comprehending how the teachers define the nature of practical work as well as its types.

Data Analysis

Sample of practical work tasks and instruction sheets were described in a tabular format. The description was what we saw on the official documents like the instructions given to the students as well as how they responded in their practical work tasks. 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). 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 of case studies " often the patterns will be known in advance, drawn from research questions, serving as a template for analysis". The categories and codes were validated during the pilot stage (Opie, 2004). However, it did not mean that new patterns and categories that arose as the data was analysed were ignored. As the data were 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 colleagues. 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 results (Opie, 2004 and Maxwell, 1992).

Results of Research

In this section the results of the study are presented from data collected from the two cases. The categories and codes used in developing the frequency of ideas on the nature and types of practical work are presented in table 1, whilst the frequency of ideas is presented in table 2. Thereafter the results from the two cases are given.

Table 1 shows the categories and codes used to analyse teachers' ideas of the nature of practical work and its types.

Table 1. Categories and codes of the nature and types of practical work.

CATEGORY	CODE
Nature of practical work	
Learning situation that offers students 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 students develop their thinking	WD
Methodology that will give opportunities to students 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 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 2. Teachers' ideas of the nature of practical work and its types.

Code	Frequency of ideas for teacher Mpho from official documents	Frequency of ideas for teacher Mpho from interviews	Frequency of ideas for teacher Bugana from official documents	Frequency of ideas for teacher Bugana 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

Results for teacher Mpho are given followed by the results for teacher Bugana.

Teacher Mpho

Table 2 shows that teacher Mpho 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 equipment to reinforce what they have learnt during the lesson or sometimes you can use it. It depends 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 Mpho 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.

It is also shown in Table 2 that teacher Mpho' s ideas of what practical is, are based on the fact that practical work is a tool for the teacher to enhance learning. Therefore, 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 students but in group work sometimes some group will work some group will not.

As indicated in Table 2 the three main ideas; practical work as an approach that develops 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 students discover things by themselves also emerged. This is evident from this excerpt "I mean it is self-discovery, they discover things by themselves without being led by the teacher".

It was also evident in Table 2 that teacher Mpho 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.

This supports the fact that even if the students were to conduct a practical work task the teacher will still want to demonstrate first.

However, from official documents table 3 (practical work task reports and instruction sheets) a different perspective was deduced.

Table 3. Practical work tasks and instruction sheets of teacher Mpho.

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 as follows. The diagrams and illustrations are also included in what to do section. The last paragraph has the assessment questions
	Learners practical reports (student worksheet)	PR1L1M	The name of the learner on top. 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 attract 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 an 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. 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 the direction of the magnetic from N pole to S pole was. Interpretations of results then follow: 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
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 (student 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 a short time.

Key: *P1M- means practical work 1 for teacher Mpho; PR1L1M and PR1L2M - means practical work report 1 for learner 1 and 2 taught by teacher Mpho; P2M- means practical work 2 for teacher Mpho; PR2L1M and PR2L2M - means practical work report 2 for learner 1 and 2 taught by teacher Mpho.*

Teacher Mpho conducted illustration and investigation type of practical work as shown in Table 2. One of the practical work tasks (table 3) analysed had some characteristics of an investigation. This was evident from the fact that the task required students 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 (table 3) completed in teacher

Mpho'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 students as observers.

Teacher Bugana

In teacher Bugana'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 students 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 students 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 Bugana also indicated that "practical work is when you move from theoretical and get to literal things". On probing, we could then make sense of the statement that teacher Bugana expressed. The teacher wanted to indicate that practical work is the learning situation that offers opportunities to students to put theory into practice. Upon probing further, teacher Bugana also indicated that practical work is something that "you do until you get the things right". These two ideas made it very difficult for us to link them with a particular category.

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

> Err because it gives students 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.

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

Table 4. Practical work tasks and instruction sheets of teacher Bugana.

Code	Type Of Document		Description
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 indicate which one is independent or dependent with an explanation of the choice.
	Learners practical reports (student worksheet)	PR1L1B	The cover page has the learner's 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*

Code	Type Of Document		Description
		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 much brighter than the first one, even though the second one is much 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.*
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 neutralise 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 (student worksheet)	PR2L1B	The cover page has the name of the grade, learner's name, group members' names, date and a grid indicating the skill 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.)

Key: P1B- means practical work 1 for teacher Bugana; PR1L1B and PR1L2B - means practical work report 1 for learner 1 and 2 taught by teacher Bugana; P2B- means practical work 2 for teacher Bugana; PR2L1B and PR2L2B - means practical work report 2 for learner 1 and 2 taught by teacher Bugana.

After analysing one of the practical work tasks for teacher Bugana it was found that the sample of the students' laboratory reports were similar even though the cover pages showed that the sample laboratory reports were of students from different groups. Hence, we concluded that the practical work task is an illustration type of practical. Even though the task had the characteristics of an investigation the teacher coached them on how to write the reports.

Discussion

Teacher Mpho'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 students an opportunity to develop process skills (Stoffels, 2005). Practical work is also an approach that enhances students' understanding of content. Therefore, 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 Mpho, 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 task as teacher demonstration where students are observers, which was largely the case for teacher Mpho. However, teacher Mpho'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 students in practical work have to discover things by themselves. However, this idea did not manifest again in the interview. So the emphasis in general from teacher Mpho was to use practical work to enhance the comprehension of science concepts. This is not different to what Dudu and Vhurumuku (2012) indicate that the focus is on teaching science than practical work.

Teacher Bugana'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 students practice the processes of investigation (Stoffels, 2005). Processes of investigation according to Stoffels (2005) were referring to process skills. Teacher Bugana'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, the 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 Bugana of the nature of practical work can be classified as ranging from the process movement to the investigation movement.

Both teacher Mpho and Bugana's ideas had the characteristics of the investigation movement, even though partially as indicated before. It should be noted that teacher Mpho's ideas were largely inclined towards the investigation movement than teacher Bugana. However, they also differed in that teacher Mpho's ideas had also the characteristics of the discovery movement whilst teacher Bugana's ideas had the characteristics of the process movement. It should further be noted again that teacher Bugana's ideas were largely inclined towards the process movement. Teacher Mpho demonstrated one of the practical work tasks, with students 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 students observe. The reasons teacher Mpho gave of why he preferred to demonstrate whilst students 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 Mpho. Hence, it was not surprising that teacher Mpho still preferred demonstrations.

One of the practical works had as its outcome problem solving skills and students' 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. Therefore, teacher Mpho'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 tasks were the same, teacher Bugana 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. There appears to be a literature gap because there is silence in literature as it does not show practical research as a type of practical work. Teacher Bugana'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. Table 5 summarizes the teacher perceptions on the nature and types of practical work.

Table 5. Teacher perceptions on the nature and types of practical work.

	Teacher Mpho	Teacher Bugana
Nature of practical work	Investigation movement Discovery movement	Process movement Investigation movement
Types of practical work	Illustration, investigation, observations (demonstrations)	Illustration, investigation, observations (demonstrations)

The following are the reasons for the difference between their perceptions of the nature of practical work and what it is and the actual practice deduced from interviews and official documents; 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. Furthermore, both teachers each had a lesson lasting for 35 minutes of which sometimes they had double slots. Only so much can be done within that limited time, hence, it may also be the reason they also resorted to demonstrations. The science topics to be covered 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 Mpho also indicated that disciplinary issues (Stoffels, 2005) also led him to conduct demonstrations. Teacher Bugana indicated that the unavailability of the laboratory assistant hampers him from conducting many practical work tasks. This sentiment was also echoed by teacher Mpho who also indicated that he resorts to demonstrations because of the unavailability of the laboratory assistant who will clean after him.

Conclusions

It was manifested from interviews and documents analysed that teachers operated within faulty frameworks and as such practical work which they desire to do may only happen by chance and not by design. For example, teachers conducted what they call investigations which are not really investigations because they did not attempt to develop problem solving skills but merely created an opportunity to develop procedural skills. One might think that it is not important to understand the type and the nature of practical work as long as students can do what the teacher thinks is practical work. On the contrary, this study posits that it should be more beneficial in terms of time and focus if the teacher understands the nature and the type of practical he or she intends his or her students to accomplish. For that reason this comprehension should logically influence the purpose of a particular practical work. This should also minimise situations where teachers do practical work to satisfy the requirements of the assessment in the curriculum and not develop the students into depended problem solvers with insight in their physical science practical work. Teachers should do practical work because it is beneficial to them and the students, the teacher may be developing the skills and understanding of particular concepts whilst the student benefit by developing skills as well as better comprehension of concepts.

It is inferred from these two cases that teachers do have certain perceptions of the nature of practical work as well as the types of practical work thereof, but realising this in the classroom can be difficult. Teacher difficulties can range from being constrained due to lack of knowledge; how to conduct practical work; to contextual factors such as classroom size or resources and disciplinary issues. These contextual factors are being considered for optimizing practical work because they will not disappear overnight. It is suggested that that collaboration between schools on the best practices in practical work should be considered as suggested by the ministry of education in one of the South African provinces, Gauteng. According to the Member of Executive Council (MEC), Mr Panyaza Lesufi, the former Model C School and Township schools must be paired, through a programme called School-Twining so that former disadvantaged schools can benefit from the resources at the disposal of the Model C due to the former apartheid system. Furthermore, teachers themselves are encouraged not to be derailed by the contextual factors, but to work within their clusters in sharing the best practices as well as challenges and how to circumvent them. It is also encouraged that workshops on different types of practical work for different purposes be devised and this can be done at cluster levels or through science clubs for teachers. For researcher, it is an opportunity to design strategies of doing various types of practical work in under resourced classrooms and/ or overcrowded classrooms. It is also hoped that the ideas presented in this paper will add value into the discussions on practical work for other scholars to interrogate further or build from it.

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