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Exploring Grade 11 Physical Science Teachers' Perceptions of Practical Work in Mankweng Circuit, South Africa

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ABSTRACT
Practical work is critical to understanding science concepts. A case study was carried out to understand teachers' perceptions regarding practical work in Mankweng Circuit, South Africa. Four Grade 11 Physical Science teachers from different high schools were purposively selected. Data were collected through interviews, classroom observations, and teachers' portfolios. Results show that teachers' had different perceptions, enactment and motives regarding practical work. Teachers used demonstrations, narratives, and structured investigations to teach practical work, which deprived learners' science process skills. All teachers recorded one practical work in a term to fulfill the national Curriculum Policy Statement (CAPS) requirements. The study contributes to the literature on teachers' perceptions regarding practical work and gives insight into the implementation of practical work in the classrooms. The study recommends developing teachers' professional development programs that focus on how to design and implement quality practical work lessons, and to assess process skills during practical work.

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Introduction

Tafa (2012) refers to practical work as an active learning process with the responsibility of organizing what is learned. Practical work in Physical Sciences refers to hands-on demonstrations, experiments, or projects which are used to strengthen conceptual understanding (DBE, 2011). The Science Community Representing Education (SCORE) defines practical work as "hands-on" learning experience that prompts thinking about the world in which we live' Science Community Representing Education, SCORE, 2008, p. 4). That is, in Physical Sciences classrooms, practical work is an active process where learners are engaged in learning (Kolucki & Lemish, 2011). Cossa and Uamusse (2015) contend that practical work is any teaching and learning activity where learners observe and manipulate objects. During practical work, teachers correct and guide learners who experience challenges by motivating and mentoring them (Llewellyn, 2013; Ping & Osman, 2019). Ramnarain and Kibirige (2010, p. 3) assert that practical work is "characterised by the manipulation of objects, so in the laboratory, practical work takes place mainly through learners manipulating equipment." In this context, practical work is classified according to the outcome the teacher desires to achieve as 1) content outcome; and 2) process outcome. These outcomes determine the type of practical work and how it is implemented. For instance, in content outcome practical work, learners identify objects and phenomena, learn facts, concepts, relationships, as well as theories or models. In process outcome practical work, learners learn to: use standard laboratory instruments, set up and use standard apparatus, carry out standard procedures, plan investigations, process data, use data to support conclusions, and communicate the results. This implies that participation in practical work is based on apprenticeship (Anyanwu, 2013), and may take the form of demonstrations (Pekmenz et al., 2005). Practical work is widely accepted as an important component in the teaching and learning of science concepts (Toplis & Allen, 2012). Quality practical work enhances students' interest in science and develops a range of skills, science knowledge, and conceptual understanding (Science Community Representing Education, SCORE, 2008). Despite the importance of practical work, teachers' perceptions differ significantly on how to teach science concepts (Abrahams, 2007; Parkinson, 2004).

Science concepts are the building blocks for theory (Watt & van de Berg, 1995) and frameworks that provide a basis for understanding science (Anderson & Krathwohl, 2001). Scientific concepts consist of three parts: a label, a theoretical definition, and an operational definition. These concepts must be interrelated to form a theory. Labels facilitate communication in science, theoretical definitions express the meanings one attaches to concepts, while operational definitions can be measured in practical work (Watt & van de Berg, 1995). Learners' experiences during practical work build their science understanding (Science Community Representing Education, SCORE, 2008). For learners to acquire new science concepts, they must play an active role (Atwater et al. 2014) to produce the best results (Godwin et al., 2015). Thus, teaching science concepts is important in science education (Utete & Ilukena, 2019). Teaching concepts involves engaging learners in practical work dealing with various concepts. Learners should have practical experiences with concepts to build their understanding of science (Science Community Representing Education, SCORE, 2008). Godwin et al. (2015) have shown that learners' science concepts are enhanced when teachers' roles include practical work.

Bruner (1996) emphasizes the teachers' role of scaffolding in the process of teaching and learning. Bruner's theory is premised on the constructionist theory that individuals construct their own understanding of reality (Oxford, 1997). During practical work, the teacher's role changes from the transmission to facilitation and scaffolding learners. Learners ask questions to know more about the subject. They look for details from the internet (Deore, 2012), books (Ward et al., 2005), and experts (Harlen, 2006), as well as perform experiments (Wei & Li, 2017) that investigate specific phenomena. Participation in practical work can develop learners' scientific thinking and improve their practical skills. Even though practical work has much potential in improving learners' conceptualisation of science concepts, many teachers do not engage learners in practical work due to their naïve perceptions of practical work. Teachers believe that practical work is reflected in their classroom practices (Mudau & Tabane, 2015). As a result, many teachers think that what they do in class is practical work, but they do not engage learners in practical work as stipulated in the Curriculum Policy Statements (CAPS) (Kibirige & Tsamago, 2013) and if they do, it is as a "cookbook" type (Sani, 2014), which do not improve learners' understanding of science concepts. Onwu and Kyle (2011) noted that in many cases, science teaching seems to emphasize memorisation, which has no application to learners' day-to-day experiences. In a few instances, teachers assist learners to understand science concepts by using demonstrations.

During demonstrations, the teacher is the main actor, while learners observe with the intent to act later. The teacher displays how to do the activity and explains the whole process step-by-step (Ameh et al., 2007; Mundi, 2006). The teacher guides the learners to observe experimental processes to relate theoretical knowledge with practical work (Tytler, 2007). Demonstrations are advantageous because they save time; facilitate material economy; motivate lesson delivery; provide feedback; and give learners a real-life situation of using materials (Abrahams, 2009; Olaitan, 1984). Despite the importance of demonstrations, teachers and learners do not link inquiry to practical work.

Inquiry and practical work are related, though they are different because inquiry includes a critical analysis of secondary sources such as media, books, journals, and electronic databases (Kibirige & Ramnarain, 2010). According to Rönnebeck et al., (2016), inquiry involves two steps 1) conceptualisation, and 2) operationalisation. Conceptualisation includes identifying research questions, searching for information, formulating hypotheses, generating predictions, planning, designing and carrying out investigations. Operationalisation, includes definition, instructions/ intervention, and assessment (Fadzil & Saat, 2019; Rönnebeck et al., 2016). Although inquiry is critical to understanding science concepts and one of the goals for teaching science in the South African Curriculum Assessment Policy (CAPS) (Department of Education, DBE, 2011), teachers have pedagogical challenges to enact inquiry in the classroom with limited resources (Flick & Lederman, 2006; Fitzgerald et al., 2019). Within the confinement of the challenges, teachers' perceptions guide the nature of practical work in the classroom.

Perceptions are defined as an individual's comprehension of the environment (Johnson, 1994). Diefendorff and Richard (2003) define perception as an individual's opinion and understanding of the stimuli. At the societal level, teachers' perceptions are guided by the contexts in which they operate at a specific point in time (Swain et al., 1999). At a personal level, the teachers' perceptions of practical work determine learners' activities in class. Whatever the teacher does in the classroom is guided by personal perceptions. The teacher, therefore, can only act in class within the range of the perceptions regarding a phenomenon (Kenneth, 2020). If a teacher perceives practical work as a means of improving knowledge and skills, science process experiments will be emphasized (Aladejana & Aderibigbe, 2007; Swain et al., 1999, Watts, 2013). Several studies have investigated teachers' perceptions of different aspects of education. For instance, teachers' perceptions: on mobile technology usage in the United States of America (USA) (Christensen & Knezek, 2018; Parsons et.al., 2019; Thomas et al., 2013); in Northern Cyprus (Ozdamli & Uzunboylu, 2015); in Korea (Leem & Sung, 2019); in Tanzania (Msuya, 2015); and in the United Kingdom (Whyley, 2018). In a different study, Shady et al. (2013) investigated teachers' perceptions of inclusive education in the USA. A study by Kousloglou and Syrpi (2018) focused on teachers' perceptions regarding Information Communication Technology (ICT) in Greece, in Korea (Kim & Kim, 2017; Nikolopoulou & Kousloglou, 2019), and in Belgium, Montrieux et al. (2014) focused on the use of tablet devices. In Turkey, Bozkurt and Ercan (2016) studied teachers' perceptions and competencies regarding Science, Technology, Engineering, and Mathematics (STEM) education, and Joebagio and Akhyar (2018) dealt with digital teaching material development, while in Lebanon, El Takach and Yacoubian (2020) investigated science students' and teachers' perceptions of scientists.

In South Africa, Thobela and Mtapuri (2014) studied teachers' perceptions concerning Integrated Quality Management Systems (IQMS). Ramnarain (2014) examined teachers' perceptions of inquiry-based learning which includes an aspect of practical work, while Petrus (2018) studied factors that may contribute to poor performance in physical sciences. Apart from these studies, there are no other studies about teachers' perceptions regarding practical work in South African schools. Thus, there is scanty literature on teachers' perceptions regarding practical work, and this study contributes to filling that gap. Therefore, the purpose of the study was to explore teachers' perceptions of practical work in teaching physical sciences in one context in South Africa. The study sought to answer the following questions: 1) What are Grade 11 Physical Science teachers' perceptions regarding practical work in Mankweng Circuit? 2) How do Grade 11 Physical Sciences teachers conduct practical work? 3) What factors motivate or demotivate Grade 11 Physical Sciences teachers to perform practical work?

Methods

A qualitative approach that strives to capture phenomena as experienced by the participants (Creswell, 2013) was carried out because the teachers' experiences and enactment of practical work are important in enhancing science concepts (McMillan & Schumacher, 2014).

Research Design

The study used a case study design (Yin, 2014) because the researchers wanted to investigate teachers' perceptions regarding practical work. Using a case study design, the researchers collected vast amounts of data (Salkind, 2003) from multiple sources of evidence (May, 2011).

Instruments

The second author prepared the interview questions. Two experts checked interview questions for face validity and their proposed changes were incorporated before piloting process (McMillan & Schumacher, 2014). The piloting was done with two teachers teaching 30 learners per class, and this helped to improve the final version of the interview questions. A modified Practical Activity Analysis Inventory (PAAI) of Millar (2004) was used in the classroom observation schedule. The researcher designed the document analysis checklist, which was validated by two experts.

Study Group

A purposive sample (Cohen et al., 2007) of four Grade 11 Physical sciences teachers (labeled as T1-T4) participated. T1(Female) had a Secondary Teachers' Diploma (STD), Advanced Certificate in Education (ACE) and Honours degree in Management, T2 (Male), had a Bachelor's Degree in Education in Senior and Further Education and Training Phases (BEDSFP), BED Honours, T3 (Female) had a Secondary Teachers' Diploma (STD) and Advanced Certificate in Education (ACE) in Mathematics, and T4 (Male) had a Secondary Teachers' Diploma (STD). Teachers were selected based on having at least a teaching diploma and two years of teaching experience in the same school. The purpose of the sample in a qualitative approach is to gain in-depth insight and not to generalize (Creswell, 2013). Also, Creswell (2012) contends that "When selecting participants for a study, it is important to determine the size of the sample you will need" (p. 146), and a sample can range from 2 to 25 participants (Creswell, 2012). Thus, our sample of four teachers was deemed adequate for the study.

Data Collection

Data were collected through face to face interviews, classroom observations, and document analysis (teachers' portfolios) in order to explore science teachers' perceptions regarding practical work. Face to face interviews included semi-structured interviews questions (McMillan & Schumacher, 2014; Waller et al., 2016). The face-to-face interviews lasted for 45 minutes each, which was considered enough without wearing out the participants (Creswell et al., 2011). All interviews were audio-taped after participants consented to take part in the study.

Non-participant classroom observations enabled the researcher to collect information on the physical setting (Cohen et al., 2007). The researcher sat at the corner of the classroom, not obstructive to the lesson. Initially, the researcher planned to observe three lessons per teacher but ended up observing one lesson because the participants did not agree to three observations. PAAI was used for classroom observations, while a checklist was used to record classroom activities. The participants' portfolios were scrutinized because they offered different perspectives (McMillan & Schumacher, 2014). The teachers' portfolios included: lesson plans, designed practical activities, worksheets for practical work, and assessment activities.

Data Analysis

Data from interviews were analysed thematically using open, axial, and selective coding (Grbich, 2007; Strauss & Corbin, 1998). In open coding, data were read sentence by sentence to get the main ideas. Emergent sub-themes formed patterns and finally, themes. Data collected from classroom observations and documents were recorded in a table and supplemented the data collected from interviews.

Findings

This section presents the results based on the data sources: interviews, classroom observations, and teachers' portfolios.

Interviews Findings

The results of the interviews show that teachers perceived practical work differently. The results further show that all of the four teachers did practical work in the form of demonstrations and narratives. From the teachers' portfolios, it was evident that all the teachers conducted structured practical work once during each term for recording purposes. Three themes emerged from interviews: 1) teachers' different perceptions of practical work 2) teachers' enactment of practical work, and 3) teachers' motive of conducting practical work. These three themes are presented here below.

Theme 1: Teachers' Different Perceptions of Practical Work

All four teachers had different understanding of inquiry-based practical work. Their definitions of practical work differed from how practical work is defined in the CAPS. Teachers perceived practical work as an activity where learners touch materials. Presented below are some of the illustrative extracts from the participants:

T1 stated:

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

T2 mentioned:

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

T3 explained:

> *"Practical work is an activity that develops learners' understanding of science.* The teacher further mentioned: "*For example, in my case, I have more than one practical activities that my learners do in one term. Learners are asked how experiments are done, and they write down the answers."*

T4 stated:

> *Practical work is an investigation that engages learners. Learners investigate and collect results of what is happening, maybe during the observation.*

Theme 2: Teachers Enactment of Practical work

All of the four participant teachers understood the way to implement practical work is through demonstrations. Teachers preferred to conduct structured practical demonstrations. When asked about the types of practical work, presented below are some of the extracts from the participants: Teacher T1: *"I know how to experiment and to do demonstrations. Mmm… yah that's all"*. The teacher was asked how practical work was conducted, and she said: *"We have conducted demonstrations, investigations, and experiments".* In support of why she conducted practical work in the way she conducted it, teacher T1 mentioned:

> "N*ow, this is because, as you can see, we have a laboratory, but the apparatus is not enough. I demonstrate on that table, and then my learners follow from the demonstration. I do this as a precaution because my learners can hurt themselves".*

Teacher 2 understood the way to implement practical work is through demonstration. This is evident from the statement:

> *"Eish, you see if I want my learners to investigate, I will lead them to an activity that enables them to investigate very well and if they do it, it will be after I have demonstrated. Because you know we work with very limited time, I sometimes book them a laboratory at the neighbouring University, and they help us there. I do this if I have a challenge with the activity".*

When the types of practical work that he conducted were asked Teacher T2 stated: *"Errr I know problem-solving, practical activities, observations, investigations, and explorative activities".* The teacher took a long pause to respond. Teacher T2 knew different types of practical work.

Teacher T2 further stated: *"err we do investigations and explorative activities where learners observe".* The teacher further said: *"mmm you see when learners investigate, it helps them to understand scientific concepts or principles better.*

When we asked about how practical work was conducted, Teacher T2 said: *"We do investigations and experiments".* To support his view why the types were conducted, he mentioned:

> "*They help learners to understand science better. So, I may also say practical work also engages learners in the activity. I mean, you will see that learners are engaged in the activity. Experiments mmm I can say offer learners a chance to experiment with the real process of science. We have Saturdays when we come to do experiments*".

Teacher T4 also explained: "*We do investigations and demonstrations".* He also added that lack of time hindered most teachers from conducting good practical work. This was also evident from T4's statement: *"I do, I always push my learners to achieve the aims of the lesson, but in some cases, due to lack of time we do not do all the activities".*

Theme 3: Teachers' Motive of Conducting Practical Work

While the four teachers presented various reasons for conducting practical work, all of the four participant teachers expressed that they conducted practical work for reporting purposes as required in CAPS documents. They conducted practical work to satisfy the requirements of the curriculum and for learners' progression. The Physical Science program of assessment requires teachers to conduct one formal practical work per term. Practical work was conducted mainly to grade learners as per the CAPS requirements.

For example, Teacher T1 stated:

> "*To be honest with you, Mr, I only do practical work when we report per assessment guideline."* However, T1 also mentioned: "*I always want my learners to be the best performers, so that is why I conduct practical work. I also do it mainly for marks*."
>
> T4: "*We conduct practical work once or twice in a term. But the requirement is one per term CAPS. Apart from that, we have few equipment to conduct practical work we need apparatus which we don't have. The department does not offer us an apparatus, and it is only a mini-lab with few apparatus."*

The same teacher further mentioned*: "Firstly, I am pushed to do practical work in that it is recommended in the assessment plan. Secondly, I conduct practical work because learners enjoy it."*

On the other hand, T3 had a similar sentiment with the other two teachers that practical work was conducted for assessment purposes only, but she also offered another perspective. Teacher 3:

> *"I demonstrate activities to save time. And I also use this just to help learners understand. We also performed three practical activities in the laboratory. When I say three because we are required to report one practical work per term. We have a formal activity per term and the others are informal."*

However, during the interviews, T2 mentioned a different perspective as to how practical work was conducted:

> *"Eeeerr I may say when I conduct practical work, I want my learners to be engaged. I want my learners to be hands-on. I want my learners to develop investigating skills, I want my learners to be able to concentrate on what I am teaching about, and they will also be focused."*

The teacher mentioned the investigating skills; however, he did not go further into identifying those types of skills he would want learners to develop. He also mentioned that motivation keeps learners focused on the activity.

Observations Findings

Results from observations were analysed so that they could supplement the results from interviews and teachers' portfolios. The results are briefly explained, and summaries of the observations are presented as vignettes. The aim and design of the learning activities were stated in all the observed lessons. Learners were issued with hand-outs with stated procedures on how to carry out the activities. Each practical work was explained to learners before the start. At the end of each sub-section, tables are provided. Tables include vignettes and shows teachers' classroom actions. Tables present the duration of the lesson, speaker, classroom actions, and the observed teacher and learner interactions.

Lesson 1, Teacher T1

The lesson started with the revision of concepts of forces. The teacher further introduced Newton's laws of motion. The teacher explained the concepts of mass, acceleration, and velocity to learners. Hand-outs of the practical work were distributed to learners. She discussed the aim of the activity with the learners and then explained it. The activity aimed to allow learners to use the ticker timer to investigate the relationship between force and acceleration. Learners were going to investigate the effect of acceleration when mass was increased. The activity was designed with a set of stated procedures and questions which were given to the learners together with the procedure. Learners followed those steps to complete the activity. The teacher demonstrated to learners how the ticker timer works.

The teacher assembled everything, and she did not allow learners to hold the ticker timer. Learners only held the tapes. Learners observed the ticker tape placed on the ticker timer. Each group representative took the tape for the teacher to run on the ticker timer. The dots on the tape were used to calculate the time and acceleration of different masses. Each group completed the given tables, followed by a whole-class discussion. The teacher emphasized that learners should make sure that they complete the worksheets as the purpose of the activity was assessment. Table 1includes Vignette 1 and shows Teacher 1's classroom actions.

Table 1

Vignette 1 observations from teacher 1 classroom practice

Time	Speaker	Text/ teachers classroom actions	Observation
10h00-10h06	T 1	*Teacher 1: "eh, good morning class, today we are going to learn or explore the concept of acceleration, mass, gravitational force and the relationship between forces. Firstly, am I sure we all know what a force is".*	The teacher describes the aim.
10h10-10h15	T1	*"Guys can you see the design of the activity. Read though the activity and ask questions"*	The teacher read the design with the learners.
10h18-10h20	T1	*"So, now we are going to do our practical activity. I am going to give you the tapes. With those tapes you are going to bring them here and I put them under this ticker timer".*	The teacher demonstrates how the ticker timer works by pressing it and releasing the objects.
10h22-10h23	Learner	*Learner: "so we are not going to press the tape for ourselves?"*	The learner was disappointed in that he was not going to handle the equipment.
10h30-10h32	T1	*Teacher: "yes, because we only have one and it is borrowed, we don't have to break it".*	

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

Lesson 2: T2

Lesson 2 was about determining which objects obey Ohm's law. Questions on the worksheets were handed out to learners. The teacher explained to learners how each wire, voltmeter, and ammeter were going to be connected. He used a demonstration for learners to perform the experiments in groups because of limited resources. Learners in groups of five to eight collected, recorded, tabulated time-ticker data, and calculated voltage/current, resistance, and the potential difference using Ohm's law. After the experiment, the whole class discussed the findings. Also, learners answered the questions on the worksheets. Table 2 presents a summary of the observations from Teacher 2 lesson.

Table 2

Vignette 2 observations from Teacher 2 classroom practice

Time	Speaker	Teacher`s actions in the classroom	Observation
09.00-09.10	T2	*"By doing this activity, you are will be determining which objects obey Ohm`s law".*	The teacher used English; the teacher explained the aim to the learners.
09.12-09.20	T2	*"There goes the light when we connect it with the wires and the battery. Now I have two connections that I want to show you. The first one we will connect bulbs in parallel, the other one we will connect them in series. You will have to observe the brightness in different connections. Now, remember once we connect, we will have our experiment. Now let's have a look how that happens".*	Design of the learning activity.
09.23-09.35	T2	*"I am going to demonstrate one, and in your groups connect like I have connected and record the readings."*	Learners were observing the connections form the demonstration.
09.37-09.38	Learners	*"Sir, we are now we are going to connect and take recordings".*	The teacher replied, yes.

09.39-09.41	T2	*"learners, follow stated procedure when you connect the ammeter".*	Learners connected according to the illustrated picture of the procedure.
09.50-10.00	T2	*"Observe the ammeter and the voltmeter when you add bulbs and take note of the readings".*	Learners observed from one connection and recorded results.
10.05-10.10	T2	*"Then use the graph paper to plot the results. Calculate the resistance using the given formula. Draw a graph of V against I".*	

Lesson 3: Teacher T3

The lesson started with the teacher recapping the demonstration of the previous lesson. The teacher asked questions on the previous lesson and the answers to those questions were written on the board. Then the teacher introduced Chemical and Energy Change topic for the day. She also introduced different types of reactions. The teacher explained the aims of the activity to the learners to enhance their understanding of science concepts. The details of the lesson are presented in Table 3:

Table 3

Vignette 3 observations from Teacher 3 classroom practice

Time	Speaker	Text	Observation
12.03-12.09	T3	*"When doing this activity, you are going to investigate exothermic and endothermic reactions. You are going to follow the following procedure".*	The teacher explains the aim of the activity to the learners.
12.10-12.13	T3	*"If your lid does not have a hole for a straw, then cut a small hole into the lid".*	The teacher demonstrated how to cut the lid.
12.16-12.20	T3	*"Pour some citric acid into the polystyrene cup, cover the cup with its lid and record the temperature of the solution".*	The teacher further demonstrated the experiment by pouring the acid.
12.23-12.29	T3	*"Now, stir in the sodium bicarbonate, and then cover the cup again".*	Learners from different groups performed the experiment.
12.37-13.00	T3	*"Immediately record the temperature, and then take a temperature reading every two minutes after that".*	Learners completed the activity.
13.00-13.35	T3	*"Record your results and calculate. I want to find the readings on the hand-outs that I gave you".*	The teacher concluded that the learners submit reports.

Learners performed the experiment following the teacher's instructions step by step and then recorded the temperature on the hand-outs. Vinegar, steel wool, thermometer, polystyrene cup, and plastic lid were used for the second part of the experiment. The teacher indicated that the lesson would not be completed on time; instead, learners were told that the temperature of the thermometer where with steel wool wrapped around it would increase. The teacher explained that the practical work would be completed some other time.

Lesson 4, Teacher T4

The lesson began with a summary of the previous lesson, and T4 summed up the topic of inter-molecular forces. The topic included types of bonds between molecules. The teacher did not involve learners in summarising what they had learned. He narrated to them what he had covered in the lesson. Learners were required to write what he narrated in a table. The teacher did not request learners to measure the level of the liquid but instead, he explained what was likely to happen during the demonstration (Table 4).

Table 4

Vignette 4 observations from Teacher 4 classroom practice

Time	Speaker	Text	Observation
12.30-12.32	T4	*"By doing this activity, we have to investigate the properties of substances and determine how they relate to intermolecular forces. You investigate evaporation and determine its relationship with intermolecular forces".*	The teacher explained the aims.
12.36-12.39	T4	*"Read through the procedures".*	Learners read stated procedures
12.53-13.00	T4	*"We have ethanol here and its dangerous you are not going to handle it I will demonstrate for you".*	The teacher demonstrates the procedure to the learners.
13.10-13.15	T4	*"We are going to submit the results of the observations as group, I will mark each group and distribute the marks".*	After the demonstration by the teacher, the learners make deliberations about the activity.

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

Portfolios Findings

The analysed portfolios consisted of lesson plans, worksheets for practical work, and assessment records. Although the focus of this study was not on the quality of the plans, it was noted that the lesson plans needed improvement if they were going to be used for meaningful practical work. Teachers' worksheets of practical work were examined based on their design, plan, and structure of the activity. The results showed that teachers did not plan for practical work (Table 5).

Table 5

Results from teachers' portfolios

Teacher	Type of document	Evidence of practical work.
1	Teaching plan	-Does not include practical work. -No annual work schedule for practical work.
	Lesson plan	-Two lesson plans for practical work available. -The lesson plan does not cater for scientific development.
	Design of the lesson plan	-Demonstration by the teacher and learners seated in groups.
	Structure of the activity found	-Worksheet with spaces for learners to fill in their names, topic being studied and aims. -Equipment stated. -Steps are shown on how to carry out the activity. A table is given to fill in the distance and time. -Questions about the shape of the graph are given, and learners write the descriptions. ' -Space is given for learners to conclude the activity. -Practical work did not promote learners' autonomy.
	Assessment records	-No assessment plan for practical work. -Some of the records of marks for practical work are missing.
2	Teaching plan	-Available but did not cater for practical work
	Lesson plan	-Content lessons available and no lessons for practical work.
	Design of the lesson plan	-Demonstration by the teacher.
	Structure of the activity found	-The worksheets included a space to fill in learners' names, a date is indicated, and instruction is given. -Learners mix chemical and record initial and final temperatures. They then conclude if the reaction is exothermic or endothermic.
	Assessment records	-Not available. -The available mark sheet is for Continuous Assessment (CASS).

In Table 5 the teachers' lesson plans in their portfolios included structured questions. There were no practical work assessment plans.

Discussion

The purpose of the study was to investigate teachers' perceptions of practical work and to find out how teachers implemented practical work in their classrooms. The results show that teachers had different perceptions of practical work, which may have affected their classroom practices. The results reveal that most of the teachers did not plan and carry out inquiry lessons. From the interviews, three themes emerged: teachers' different perceptions of practical work, teachers' enactment of practical work, and teachers' motive of conducting practical work These themes are discussed below.

Teachers' Different Perceptions of Practical Work

From the interviews, all four sampled teachers had varied perceptions of the concept of practical work (Table 4). Teacher 1 and Teacher 2 perceived practical work as learners making observations in the laboratory without specifying the activities for learners. Teachers believed that when learners submit reports, they would have fulfilled practical work requirements, which is an incorrect interpretation of practical work. This finding supports Ramnarain and Fortus (2013), who found that teachers had different perceptions of the content in the revised curriculum. According to Teacher 3, practical work was a tool used to develop scientific knowledge and also as a source of motivation. The teacher could not describe the activities that are involved in good practical work. It was also evident during classroom observations that his teaching was not learner-centred. Participant teachers' definitions of practical work were related to the way they conducted practical work. It suggests that either the teachers did not perceive practical work to be critical to the learners' conceptualisation of science concepts, or teachers lacked improvisation skills. Teachers reasoned from their experience and knowledge of practical work concerning the way they conduct practical work. The study finding corroborates the findings by Mudau and Tabane (2015), who indicated that teachers operated within a faulty framework of what they considered to be practical work. The findings further suggest that teachers had inadequate pedagogical knowledge which would assist in carrying out practical work. It was deemed so because teachers mentioned that learners were going to be engaged in activities, yet they could not specify the activities of the experiment. However, this was not a surprise because there was no evidence of practical work lesson plans in teachers' portfolios as specified in CAPS.

Teachers Enactment of Practical Work

The analysis of teachers' interviews and classroom observations reveal that teachers conducted demonstrations as practical work (Table 4). This result shows that Physical Sciences was taught using demonstrations and explanations. This observation agrees with (Pekmenz et al., 2005) who reported that teachers preferred to demonstrate. Similarly, a study in Kenya by Ituma et al. (2015) found that 64 % of the participant teachers used demonstrations. This could be as a result of limited resources in schools and negative perceptions towards science (Ramnarain & Hlatswayo, 2018). In addition, teachers may have had challenges to teach practical work as a hands-on learning experience as advocated by Cossa and Uamusse (2015), who emphasise that during practical work, learners must observe and manipulate objects. The teachers' reluctance to facilitate authentic practical work may indicate that teachers lacked the knowledge to design suitable activities to teach science topics.

Similarly, Anza et al. (2016) found, among other factors, that affect practical work in chemistry was the teachers' inadequate knowledge of conducting practical work. The teachers in the study used structured activities which tantamount to "cook-books" (Sani, 2014; Stoffels, 2005), which do not improve learners' attitudes towards science (Sharpe & Abrahams, 2020) and understanding of science concepts (İlter, 2017). This observation concurs with Kibirige and Tsamago (2013), who also found that teachers did not conduct practical work. In the same vein, Onwu and Kyle (2011) noted that in many cases, science teaching seems to emphasize memorisation, which has no application to learners' day-to-day experiences. Memorisation and structured experiments deny learners the opportunity to develop problem-solving skills, which are useful in a daily life. Probably, teachers did not perceive practical work as a means of improving knowledge and skills, and not much emphasis was placed on science process activities (Aladejana & Aderibigbe, 2007; Hodson, 2014; Swain et al., 1999; Watts, 2013).

All of the four participant teachers stressed the importance of following the specific aims in the curriculum; however, they did not design activities that could enable learners to do practical work. It was also noted during the lesson observations that much of the time allocated to practical work were used for demonstrations and lectures on how to answer stake examination theory papers. During interviews, teachers stated that the importance of practical work is to offer learners a chance to manipulate equipment; however, learners were not exposed to equipment during their learning. This was not a surprise because Teacher 1 understood practical work to be synonymous with demonstrations. The other teachers used narratives and formal structured investigations which do not give learners opportunities to think and make interpretations of the results (Park et al., 2016). The teachers' use of narratives and structured investigations are in contrast with the constructivism theory (Oxford, 1997), where learners construct knowledge. The teachers' roles also change to facilitating knowledge construction as proposed by Bruner (1996). Data from classroom observations showed that there was no correlation between the Physical Science curriculum requirements and the actual classroom practices which concur with Kibirige and Teffo's (2014) study. Narrating to learners how to do practical work misrepresents science learning and encourages rote learning rather than meaningful inquiry. Learners are denied opportunities to plan hands-on and minds-on activities that would help them to construct their own knowledge and to relate it to science concepts (Cossa et al., 2008; Hofstein et al., 2007). Also, there could be a lack of research culture among teachers and a lack of a clear vision of the aims of practical work (Cossa, 2007).

Teachers' Motives of Conducting Practical Work

The teachers regarded the motives of practical work as a pre-requisite to satisfy a CAPS requirement (Department of Basic Education, 2011), however, it was not necessarily for learning and mastering science concepts. After all, one practical work required per term as evidence of doing practical work cannot be adequate for science mastery of the different science concepts. For instance, Teacher 1 indicated that she was pushed to conduct practical work because the Head of the Department of the school demanded marks from the practical activity for record purposes. This comment is not surprising because the grading sheets found in the sampled teachers' portfolios had grades from formal tests and one practical work, which is required by the CAPS document. Also, there was no evidence of teachers assessing learners' practical skills during practical activities. The lack of practical work assessment may be because teachers lack the knowledge to design learners' assessment that reflects manipulative skills (Fadzil & Saat, 2019). Teachers mainly focused on written group reports. These findings agree with Mudau and Tabane (2015), who found that only reports were assessed and not any enactment of learners during practical work. Failure to assess practical work may be related to the teachers' naïve perceptions regarding practical work, or their incompetence to assess practical work. It is most likely, teachers did not perceive practical work as a means of improving learners' knowledge and process skills (Swain et al., 2013). These observations concur with Flick and Lederman (2006), Effendi-Hasibuan and Mukminin (2019), and Akuma and Callaghan (2019) revealed that teachers experienced challenges in implementing explicit and implicit inquiry teaching in the classroom. Besides, teachers indicated that they lacked the resources to conduct practical work. Insufficient resources in schools have been reported by Kanamugire et al. (2019) who states that a lack of laboratory facilities is a long-standing challenge in schools. Also, teachers pointed out that they could not find the time to carry out all the practical work as allocated in the pacesetters (Schemes of work) from the Department of Education.

Conversely, Hofstein et al. (2013) state that science teachers have improved in their pedagogy in the last decade. This improvement, unfortunately, excludes teachers' knowledge of conducting practical work in South Africa schools in this study. According to Osborne (2011), there are three interrelated issues (1) investigating, designing experiments and collecting, analysing, and interpreting data; (2) developing explanations, solutions, developing hypotheses; and (3) evaluation where scientists engage in arguments, evaluating their data, and identifying flaws. Furthermore, mathematical deduction, modeling, categorisation, probabilistic thinking, and history-based thinking were not considered. The findings are not surprising because Kang and Wallace (2005) contend that there is a direct correlation between science teachers' epistemological beliefs, teaching goals and their use of laboratory work. From our study, teachers did not mention any of those tenets, suggesting that teachers had naïve ideas regarding practical work. Teachers epistemology for conducting practical work was not explored and therefore need further study. The findings in this study contribute to literature regarding teachers' perceptions of inquiry-based practical work and how it differs from teacher to teacher. These differences suggest that teachers have challenges in implementing practical work to enhance learners' science concepts.

Conclusion and Implications

The science teachers had different perceptions regarding practical work, and their implementation of practical work differed from what CAPS recommends. The majority of teachers used narratives to teach practical work for learners to memorise how experiments are done, and all four teachers did practical work in the form of demonstrations. In both instances, there was little effort to consider learners' motivation, and to achieve either the content or process outcomes. All the teachers recorded one practical work activity to comply with CAPS requirements. These practices are contrary to teaching science for conceptual understanding. Thus, none of the teachers used practical work as a means of teaching learners' science process skills and facilitating the understanding of science concepts. Teachers did not plan for practical lessons as required by the CAPS document. The study recommends teachers' professional development courses on how: to design quality practical work lesson plans; to conduct and assess skills during practical work. Besides, the Department of Education should consider introducing a final or "stake" practical work for high schools and provide opportunities for teachers' learning visits to countries like Zimbabwe, Kenya, Uganda, and the United Kingdom where stake practical work examinations take place and Germany where the best practical work is done.

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