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South African physical science teachers' classroom language for enhanced understanding of science concepts

by

Govero Memory Kurwa

A Research Report submitted to Faculty of Science,

University of the Witwatersrand, in partial fulfilment of the requirements for the degree of

Masters of Science

Johannesburg

July 2016

ABSTRACT

The study reported in this research report was motivated by the continuous poor performance by South African learners in physical sciences. This poor performance is evidenced by the below expectations year in, year out grade 12 physical science final examinations results. Several factors may be contributing to this poor performance such as lack of resources (both financial and human resources), overcrowding, ineffective teaching methods, and the language of teaching and learning. The assertion for this study was that teacher's oral classroom instructional language impacts on learning of classroom science. The study, hence investigated how South African physical science teachers use their oral instructional language to enhance the understanding of science concepts.

The raw data was gathered through naturalistic observation and video recording of physical science lessons by two participant South African physical science teachers drawn from two different high schools located in the Gauteng Province. The two school were chosen on the basis of their matric results that are also below average. Follow up educator interviews were also conducted and video recorded. The videos of the lesson observations and educator interviews were transcribed verbatim and analysed.

The study revealed that the participant educators were not explaining the meanings of all technical and non-technical words that were used in the observed lessons. Teachers did not distinguish between the everyday meanings and scientific meanings of non-technical words used. Participant educators did not seek and make use of the participant learners' pre-instructional meanings of non-technical words to help learners understand better the new scientific meanings of these words. One of the participant educators did not engage learners in the ongoing lesson talk.

The findings of this study will sensitise physical science teachers to important role of their oral instructional language to successful learning of science concepts in the classroom. This might help in ensuring science teachers use their oral instructional language effectively to enhance understanding of science concepts, by adopting teaching approaches that facilitate shared meanings of vocabulary used in science classrooms.

Key words: technical and non-technical words, instructional language, science language.

DECLARATION

I declare that this research report, titled:

South African physical science teachers' classroom language for enhanced understanding of science concepts,

is my own work and that all sources l have used or quoted have been indicated and acknowledged by means of a complete references list.

It is being submitted for the degree of Masters of Science at the University of the Witwatersrand, Johannesburg, South Africa. It has not been submitted before for any degree or examination purposes at any other university.

Signature_____ Date_____

G. M. Kurwa (691428)

Protocol Number: 2015ECE055M

ACKNOWLEDGEMENTS

My sincere gratitude and appreciation to the following:

- My supervisor Prof Samuel Ouma Oyoo for his tireless professional guidance as l completed this study
- NRF who provided the financial support that made it possible for me to undertake my studies
- The two participant physical science teachers who made this investigation possible and their learners who allowed me into their classes
- My wonderful and loving sons for their never dying love and support that encourage me to keep on going even when sometimes the going gets tough
- A special thanks to my long-time friend Webster Rusinga for all the moral and technical support
- Finally, to my almighty God who has blessed me with the power and opportunity to complete this study.

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Chapter 1: Introduction to the Study

1.1 Introduction

This study focused on the effect of the South African physical sciences teachers' oral instructional language on learning of science. The study has been motivated by the deemed importance of science in both human, social and economic development. The South African government, like other governments the world over, believes there is a link between science education and socio-economic development (Vhurumuku, Holtman, Mikalsen, & Kolsto, 2000). It is then the utmost wish of any country's government, South Africa included, that its science learners excel in science to achieve the envisaged outcomes of excellence in science education. The outcomes of a successful science education include production of skilled human resources such as engineers, doctors, research scientists, teachers, and many others. Science education is a means for producing scientifically literate citizens believed to be free from false beliefs and superstitions, who can lead healthy life styles, know and appreciate sustainable use of the environment, and adapt easily to the fast technologically changing world, just to mention a few of the advantages of science education.

1.2 Background to the Study

The UNESCO report of The International Commission on Education for the Twenty-first Century (1996) cited in Zuljan and Vogrinc (2010) states that "none of the talents which are hidden like buried treasure in every person must be left untapped" (p. 10). This quote aptly summarises the importance of education in general, and the teacher in particular, in unlocking the potentials that are hidden in learners. In order to make this a reality, science teachers must do everything in their power to ensure that there is effective teaching that facilitates successful learning of science by learners in the science classrooms.

The teacher is pivotal to successful teaching and learning of science. The science teacher should not only have the appropriate subject content, but should also be able to represent the subject matter in such a way that it is easy for learners to comprehend the science concepts being taught. Mji and Makgato (2006) refer to this ability as a teacher's pedagogical content knowledge (PCK). A good PCK also includes the ability of a science teacher to use language that is to the level of the learners which will enable learners to understand subject matter while at the same time learning the appropriate language of science. In science teaching, the teacher not only has an important role of initiating science learners into the science subculture but also into its language. Aikenhead (1996) states that "scientists share a well-defined meaning and symbols with which they interact socially" (p. 8). Meaning, and hence understanding, of the science subject matter is embedded within the language of science. The role of the science teacher is then to assist learners to acquire the appropriate language that will enable learners to access scientific knowledge necessary for learners to enter into the science subculture.

The teacher, as the knowledgeable other in the classroom, has the ultimate role of ensuring that learners acquire the necessary science knowledge. All over the world, science is regarded as a practical subject (Henderson and Wellington, 1998; Oyoo, 2012), and as such practical activity is regarded as the most effective teaching approach in science to enhance understanding of science concepts. Besides practical activity, science teachers also make use of metaphors and analogies when teaching science. Practical activities, metaphors and analogies simplify learning by providing concrete foundations on which abstract science concepts are then built (Henderson and Wellington, 1998). However, Oyoo (2012) points out that instructional language (oral or written texts) is a necessity to effective teaching of science. Activities done in the classroom are mediated by talk during which teachers and learners share views and ideas. Teacher uses language for both transmitting knowledge (lecturing) and initiating classroom discussion around science ideas and concepts. Teacher-learner interactions are necessary for

creating classroom discussions in which learners socially share ideas and practise using correct science language. Through teacher-learner interactions, learners are able to use words used by teacher and own these words. This enables learners to acquire proficiency in the language of science. It is a necessity for learners to acquire the appropriate language so that they become familiar to the ways in which language is used to communicate meaning in science. Quinn, Lee & Valdes (2014) posit that language is necessary for "students to communicate and reflect about ideas and to engage with others in sense-making talk and activity" (p. 8). Therefore, besides listening to the teacher, learners should also engage in classroom talk so that they learn to use the science language appropriately as they communicate their ideas in oral or written form.

Therefore, language is a learning tool used by both teachers and students to talk about science ideas; and to explain the meanings behind the practical activities, metaphors and analogies that are used in the teaching and learning process, as expressed in the following quote:

> Teachers convey the ideas of science by trying their best to explain the concepts and operations clearly....make use of metaphors....demonstrations and practical work to flesh out abstractions...utilise projects and discussions for involving students in the subject matter. (Matthews, 1998, p. 9 cited in Oyoo, 2012, p. 850)

Of all the methods used in science classroom to enhance understanding of science concepts, it has been noted that classroom talk dominates in science classrooms (Oyoo, 2012). The following quote by Edwards and Mercer (1987) cited in Oyoo (2012) underscores the dominance of teacher talk during teaching and learning of science, "(a) for about two thirds of the time someone is talking; (b) about two thirds of this talk is the teacher's talk; (c) about two thirds of the teacher's talk consists of lecturing or asking questions" (p. 851). It is evident from the above quote that classroom talk, through the use of oral language is a teacher's prime teaching tool and is therefore central to successful teaching and learning of science. The focus of this study is therefore on the quality of the teacher's oral language because it transcends all

other methods or practices that a science teacher may be using to enhance understanding of science knowledge. The teacher's classroom language provides both an environment for learning the language of instruction in general and in particular the language of science as well as the science content itself (Quinn et al, 2014). It follows therefore that the quality of the teacher's classroom language impacts on the quality of learning that results thereof, as evidenced in the following quote by Henderson and Wellington (1998, p. 36), "In all parts of the curriculum, the quality of classroom language is bound up with the quality of learning". Therefore, quality science learning is premised on the quality of the teacher's classroom language as suggested by Henderson and Wellington (1998).

1.3 Problem Statement

South African physical science learners' performance continues to be below expectations. The Department of Basic Education (DBE) has to constantly deal with the challenge of unacceptable grade 12 NSC results, in general, and in particular, the poor results in physical sciences. Table 1.1 below shows the trend in physical sciences from 2012 to 2014. The following observations can be drawn from the data in Table 1.1. A smaller proportion of the grade 12 class enrols for, and ends up sitting for the physical sciences examinations each year. The number of learners enrolling for science is generally declining from year to year. The percentage of learners achieving 30% and above is low. In the South African educational policy, a 30% score mark is considered a pass in physical sciences. This is a very low mark that one would expect a majority of the South African learners to meet with ease. However, as indicated in Table 1.1, this is a feat most of the grade 12 learners cannot achieve.

Table 1.1: Physical Science Key Indicators

Year	Start of grade 12: total enrollment	Science enrollment	% of matrics enrolled for science	End of grade12: Total exams takers	Science exams takers	% of exam takers writing Science	Achieved at 30% and above	% at 30% and above
2011	534 498	184 052	34%	496 090	180 585	36.4%	96 441	53.4%
2012	551 837	182 126	33%	511 152	179 194	35.1%	109 918	61.3%
2013	576 490	187 109	32%	562 112	184 383	32.8%	124 206	67.4%
2014	550 127	171 549	31%	532 860	167 997	31.5%	103 348	61.5%

Source: NSC Examination 2014 Technical Report.

Due to this continuous poor performance in science, South Africa's science education is persistently ranked poorly compared to other countries. Mji and Makgato (2006) identified factors such as unqualified and under-qualified teachers, overcrowded and non-equipped classrooms, outdated teaching practices, lack of basic content knowledge by the science teachers and general language usage in the science classrooms as some of the factors contributing to this poor performance. According to Mji and Makgato (200), "the combination of all these factors has in turn produced a new generation of teachers who are further perpetuating the cycle of mediocrity" (p. 254). The foregoing quote further stresses the importance of the teacher in learning of science. Mji and Makgato (2006) in my opinion suggest that one way of changing the status quo will be to address the teacher issues first, especially with respect to their content knowledge and language usage in the science classroom. Therefore this study is meant to fill in the gap on the effect of language usage by science teachers as a way of addressing the poor performance in science.

1.4 Rationale of Study

The South African Department of Education (DOE) is concerned with the continued poor performance in science by learners and offers assistance to schools in form of material, financial, and human development support as a means to turn around this persistent poor performance in science. From personal experience as a practising science teacher, I have often

attended clustered and provincial workshops targeted at improving science teachers' content knowledge. These workshops are run by organisations such as Sangari who are contracted by the Dinaledi Schools Project to do so. However, there are no workshops conducted to address teachers' oral instructional needs so that they are better prepared to address the language challenge in science learning. In my opinion, workshops on language usage are as important as content knowledge workshops. These language workshops will go a long way to equip science teachers with the appropriate quality and language level that will assist teachers to impart language skills to their respective learners. A good science language in science teachers will most likely translate into a quality science language proficiency in learners that will enable shared understanding of words used in science lessons.

Learners should have a clear understanding of the language used in the science classroom in order to access scientific knowledge. Science knowledge consists mainly of unfamiliar concepts. The role of the science teacher in science learning is therefore to use language to make the unfamiliar science concepts to become familiar. The purpose of this study is therefore to investigate how the South African science teachers use their classroom talk (language) to make learners understand science concepts.

1.5 Aims of the Study

The study is to get an insight on how South African physical science teachers are using their classroom oral instructional language to:

- Explain meanings of both technical and non-technical words used in science.
- Promote Zone of proximal development (ZPD) in acquisition of both the content and language of science.
- Initiate a communication pattern that encourages learners' participation in the ongoing classroom discourse.

Providing meanings of words used in science is necessary for shared understanding between the science teacher and his/her learners. However, providing the meanings of words used in science alone may not be sufficient for effective teaching. Msimanga and Lelliot (2012) posit that a science teacher should also be able to use his/her classroom language for both instruction and scaffolding of learners. Teachers should scaffold and support their learners through use of their language to encourage and assist learners to do more in terms of acquiring the language of science. Through scaffolding, a science teacher can promote ZPD in language acquisition so that learners can make greater strides towards acquiring the appropriate language vocabulary and knowledge construction than if no scaffolding is done. A teacher can scaffold and support learners in this regard by adopting a communication pattern that allows teacher- learner interaction so that learners also participate in the lesson conversations. Aguiar, Mortimer, and Scott (2010) define patterns of interactions as "simple, but distinctive, patterns of talk which emerge between teacher and students during ongoing classroom discourse" (p. 176). An example of a communication pattern that allows teacher-learner interaction is the initiation-response-feedback (I-R-F) communication pattern. In this communication pattern basically the teacher initiates dialogue by asking learners questions as the lesson progresses. The learners answer these questions and the teacher gives feedback to the learners' responses. The feedback can be in form of questions that probe the learner further or as a correction to an incorrect response. Such teacher-learner interactions enable the learners to verbalise their ideas. Through verbalisation, learners learn how to use science words correctly and become familiar with the appropriate way of talking in science and this might assist learners to become competent in the scientific social language (Leach & Scott, 2003). Verbalisation is also a key component of knowledge construction (Msimanga & Lelliot, 2012). At the same time the teacher can also assess learners' understanding of concepts as the lesson progresses (Msimanga & Lelliot, 2012). This means that the teacher can identify and address any misconceptions

learners have immediately, instead of discovering these misconceptions when learners are assessed. This will assist in shaping "students' views to fit criteria of what counts as scientific knowledge as known within the scientific community" (Oyoo, 2012, p. 851).The quality and usefulness of these interactions are dependent on the level of the teacher's oral language. The teacher's classroom language must be rich in vocabulary (both general language and science specific vocabulary) so that he/she can effectively instruct and encourage learners' participation in classroom conversations.

1.6 Research Questions

The research questions for this study are:

1. How are South African physical science teachers using oral language during teaching to assist learners understand science concepts?
2. What other factors contribute to observed teachers' language use styles?

In this study, l chose to focus on how the South African physical science teachers are using their oral instructional language to enhance understanding science due to the important role of the teacher in making available "to the learners the resources necessary for meaningful engagement in the process of knowledge construction" (Msimanga & Lelliot, 2012, p. 194). Language is the crucial resource learners need in this knowledge- construction process. The study is important to South Africa because of the possibility that a more directed teacher's classroom language will help improve learners' understanding of the use of language in the science classrooms. Understanding of the language of science will result in improved comprehension of science content. This improved comprehension of the science concepts should lead to better performance in physical science by South Africa science learners. This will go a long way to help improve the current poor performance in physical science and perhaps transform the gloomy picture portrayed in Table 1.1.

1.7 Chapter Summary

In this chapter, introduction and overview of the study has been discussed. The overview of this study includes background information to the study, problem statement, rationale of the study and the research questions the study sought to answer. Here are the main points again. The world over, governments rely on science education to produce professionals such as doctors, research scientists, nurses and teachers that are necessary for human, social and economic development. However, the South African Department of Education is confronted with continuous poor performance by its learners in science especially in matric science examinations as summarised in Table 1.1 on page 5. The physical science is central to good performance in science. The premise of this study is that on top of having sufficient subject content knowledge, the teacher's classroom language ought to be such that it enhances understanding of the science concepts being taught. The focus of this study is on how South African physical are using their classroom English language to enhance understanding of science concepts.

The rest of the report is structured as follows. In Chapter 2 the theoretical and conceptual framework informing the study is discussed. This chapter also discusses the literature relevant to the study.

Chapter 3 discusses the overall research approach used in this study, the methods of data collection used, sampling of participants and how the actual study was carried out. It also discusses the data analysis strategy used to analyse the qualitative text obtained from verbatim transcripts of lesson observations video recordings and video recordings of educator interviews.

Chapter 4 presents the actual data analysis and the findings of the study and answers to the research questions.

Lastly, Chapter 5 reports on summary of findings of the study, implications and recommendations of the study. My reflections resulting from conducting this study are also presented in this chapter.

Chapter 2: Theoretical Framework and Literature Review

2.1 Introduction

This chapter starts by a discussion of the theoretical and conceptual framework that guided this study. The chapter also reviews literature relevant to the study. A brief discussion of what learning science is provided. The literature review also discusses the following: role of language in science learning, the nature of teacher's classroom language, the general difficulty of the teacher's classroom language, addressing the language problem in the classroom and the language context in South Africa. First l present the theoretical and conceptual framework that guided the study.

2.2 Theoretical and Conceptual Framework – why focus on teacher's classroom language?

The theoretical underpinning of this study is constructivism including Piaget's personal constructivism (Hassard & Dias, 2009) and Vygotsky's (1978) socio-cultural constructivism). An important aspect of constructivism is that learning is dependent on the ability of individuals to construct his/her meanings of the world around them. Language is considered an essential tool that individuals use in construction of their own meanings of world phenomena.

Language has been defined in Oyoo (2007) as "a system of sounds, meanings, and structure with which we make sense of the world around us. It functions as …means of transmission of knowledge…" (p. 231). Language plays an important role in learning. Constructivists, for example, Jean Piaget who lived in the years 1896-1980, view learning as an active process during which learners construct knowledge and make sense of the world around them (Hassard & Dias, 2009). Learners therefore, use language in this meaning making process. In the classroom, language, in its verbal or non-verbal forms, is used as a tool for social interaction between teacher and learners. Learners access content through language in order to construct concepts and change pre-instruction conceptions they have about the world around them.

Classroom language as a powerful tool for both intellectual and educational development should be such that it promotes comprehension of subject matter being learnt, and allows learners to construct their own ideas fast and efficiently. As already stated in section 1.4, the particular focus of this study is on how science teachers use their oral language to assist learners to acquire proficiency in the classroom science language as a way of enhancing comprehension of science knowledge. It is imperative that learners acquire proficiency in the language of science so that they are able to effectively acquire the science knowledge as well, based on the following argument that has provided a link between words, knowledge and language.

> All of what we customary call "knowledge" is language. Which means that the key to understanding a "subject" is to understand its language … what we call a subject is its language? A "discipline" is a way of knowing, and whatever is known is inseparable from the symbols (**mostly words**) in which the knowing is codified. [Postman & Weingartner (1971, p. 102) cited in Hodson (2009, p. 242)].

The argument by Postman and Weingartner (1971) immediately above was adopted as the conceptual framework for this study; it suggests that the key to understanding science is to understand the total language used in science classroom. This also makes it apparent that a learner's understanding of the science classroom language will be achieved when a learner can access the scientific knowledge codified in the specific meanings of words that make up the science language. Understanding the meaning of words that make up the teacher's oral English language is a prelude to understanding of the language of science classroom necessary for quality science learning to occur.

The focus on the teacher's classroom language was motivated by the following reasons. Firstly, the recognised role of language in learning. Secondly, the need for intervention by the teacher as the knowledgeable other; and lastly, the fact that most of the classroom talk is dominated by teacher talk (Oyoo, 2012).

2.3 Nature of science teacher's classroom language

Oyoo (2012) classifies language used for instruction in science classrooms into two components: technical component and non-technical component. According to Oyoo (ibid), the technical component consists of technical words or terminologies specific to a science subject, which he defines as "everyday words deliberately used as science words and have new (scientific) meanings in addition to their everyday meanings" (p. 851). Oyoo (ibid) identifies examples of technical words as mass, force, names of chemical substances, plants, organs, apparatus and processes (p. 851). He further argues that these science words have fixed meanings that should be known in the international science community circles. Therefore, these science words represent the science culture with a unique language different from any other culture. The new scientific meanings that these words acquire limit their use as part of social conversations outside the science classroom. Technical words are therefore foreign to science learners since they do not often form part of their everyday language.

Oyoo (2012) also points out that the non-technical component of the science language is made up of non-technical words, which he defined as "part of the science language that may be recognised as the medium of classroom instruction or interaction as separate from the technical terms" (p. 852). Ali and Ismail (2006) also define non-technical words as words that "may have one or many meanings in everyday language, but which have a precise and sometimes different meaning when used in the scientific context" (p. 75). . These words are used in science teaching and learning to enhance the register or comprehension of science terminologies.

The non-technical component of the teacher's classroom language consists of three categories namely: non-technical words in the science context, metarepresentational terms and logical connectives (Oyoo, 2012). Non-technical words in the science context are words that commonly form everyday conversations but adopt specific meanings, sometimes different

from their everyday meanings, when used in the science context. Examples of non-technical words include *random, predict, spontaneous, negligible* and *disintegrate.* Their contextual meanings when presented in a science mean that the understanding of their contextual meanings is necessary to the process of learning specific science subjects.

Metarepresentational terms, inclusive of metalinguistic and metacognitive signify thinking. According to Oyoo (2012) metalinguistic terms are words which represent the verb *to say,* e.g. *define, describe, explain, argue,* and *criticize,* while metacognitive terms represent the verb *to think,* e.g. *calculate, analyse* and *predict.* Oyoo (2012) refers to metarepresentational terms as "key terms/operative words" (p. 853), since these words are often used during questioning in talk-led classrooms or in examinations. Having knowledge of the meanings of these words may enhance students' understanding of the demands of the examination questions which will help learners in coming up with more appropriate responses to these question, and may also enhance their participation in classroom interactions (Oyoo, 2012).

Logical connectives are "words or phrases which serve as links between sentences, or between propositions within a sentence, or between a proposition and a concept", Gardener (1977a, p. v) cited in Oyoo (2012, p. 853). Examples of logical connectives include *conversely, if, moreover, because, therefore, in order to, consequently, by means of,* and *since* (Oyoo, 2011; 2012). The importance of these words is that these words "are commonly used in the oral or written discourses of science to link observation to inference, theory to explanation, hypothesis to experiment, experiment to findings" (Fensham, (2004) cited in Oyoo, (2012), p. 853). Understanding of logical connectives enhances learners' classroom participation; improve understanding of science learning processes and teacher's classroom language (Oyoo, 2012).

It is evident then that learners need to understand the meaning of all words that make up the science teacher's classroom language in order to participate meaningfully in the meaning-making process that leads to effective science learning.

2.4 General difficulty of science teacher's classroom language

Oyoo (2007; 2012,) contends that the entire language used in instruction of science is generally difficult. Although technical words pose a problem because of their foreignness, students seem to be able to cope reasonably well with these words (Ali & Ismail, 2006), English non-technical terms cause an even greater challenge to learners. Oyoo (2012) has reported that findings from studies that focus on learners' understanding of non-technical words show that learners encounter difficulties with the non-technical component of the science classroom language of instruction consisting of three categories, namely *non-technical words in the science context, metarepresentational terms* and *logical connectives*, irrespective of their linguistic circumstances, gender or cultural backgrounds.

Several cross national studies done so far, all based on Paul Gardner's 1971 pioneer study, have all found that learners experience challenges in comprehending meanings of non-technical words. These studies include Gardner (1971, 1972, 1974, and 1976), Cassels and Johnstone (1980, 1985), Marshall and Gilmour (1991), Marshall, Gilmour and Lewis (1991), Pickersgill and Lock (1991), Tao (1994), Farell and Ventura (1998), Prophet and Towse (1999), and Oyoo (2000). The following are the different types of difficulties identified from the stated studies that learners encounter with non-technical words used in the science language:

- Learners often confuse words which are graphologically or phonetically similar: for example *instinct* with *instant, insist* and *resist* with *persist*, and *generalise* with *generate, accumulate* with *accommodate*
- Students confuse words with their antonyms (opposites), for example *fill* with *evacuate*, *take in* with *emit*

- Learners often confuse words in the same semantic field, for example *detect* with *project, isolate* with *insulate*; *theory* with *fact* or *belief.*

Oyoo (2007, p. 234)

This difficulty is due a number of factors. First, the language of teaching and learning, English in this case is generally a problem on its own (Mji & Makgato, 2002), but this difficulty might be magnified for English second language learners, especially, if they are not exposed to good instruction to facilitate acquisition of proficiency in the language of instruction (Quinn, Lee & Valdes, 2014). Secondly, discipline specific words (technical terms) that were invented and defined for science are foreign to most students, even to learners whose home language is the same as the language of instruction (English). Thirdly, the fact everyday words i.e. non-technical words presented in a science words acquire science specific meanings that in most cases are different from their everyday meanings, e.g., *force, work, power,* presents a challenge to learners. The overlaps in usage of these everyday words may cause confusion in learners due to polysemy of such words may result in development of alternative conceptions, also called misconceptions. Clerk and Rutherford (2000) argue that "a misconception exists if the model constructed by an individual fails to match the model accepted by the mainstream science community in a given situation" (p. 704). Lack of comprehension of both technical and non-technical terms that make up the classroom language, hence the teacher's oral language affects the ability of learners to construct correct knowledge, ideas and concepts in science which may lead to poor performance in science.

The foregoing factors show that learners generally have difficulty with all the words that make up a science teacher's classroom language. Oyoo (2007) attests to the idea that the general difficulty of science words, hence school science, is a well-known worldwide phenomenon that varies in extent depending on the specific circumstances.

South African learners are likely to have the same difficulties as so far highlighted. My 2014 study that investigated South African physical science learners' difficulties with words used in science, with a special focus on non-technical words (although it was a case study), showed that the participant learners also had a challenge with comprehension of non-technical words. The difficulty of the total language of science and the role of the science teacher in exposing learners to the language of science, provided the foundation of this study.

2.5 What is science learning?

Learning, in general, can be defined as acquisition of knowledge through study, experience or instruction. Therefore, learning results in change of one's knowledge (e.g. ideas, beliefs, or way of thinking). Learning of science is called conceptual change (Duit (1999); Duit & Treagust (2003); Hewson (1992); Posner, Strike, Hewson, & Gertzog (1982)). Duit and Treagust (2003) define conceptual change as "learning pathways from students' pre-instructional conceptions to the science concepts to be learned" (p. 673). The quote shows that learners already have own conceptions even before classroom science instruction commences. I purposely adopted the definition of science learning as conceptual change because it is commensurate with the theoretical and conceptual framework that guided my study. According to Duit (1999), conceptual change has become the term used to denote learning science from a constructivist perspective. What follows is a brief description of conceptual change as theorised by Posner et al. (1982) in their Conceptual Change Model (CCM).

Research literature (e.g. Duit & Treagust (2003); Posner et al., (1982)) attest to the fact that learners do not come to the science classroom as "blank slates" but rather have their own ideas about phenomena and concepts to be taught in the science classroom. Literature (e.g. Duit & Treagust (2003), refers to students' conceptions as pre-instructional conceptions, misconceptions, naïve beliefs or alternative frameworks. The students' conceptions are based

on their observations and personal experiences. Evidently, more often than not, the conceptions that learners bring to the science classroom are incompatible with science as evidenced by the following quote taken from Duit and Treagust (2003), "rather, students already hold deeply rooted conceptions and ideas that are not in harmony with science views or are even in stark contrast to them" (p. 671). It is then logical to conclude that learning science entails acquiring new conceptions that are compatible with our current understanding of science and in many incidences, different from the "students' everyday commonsense ideas" (Scott, 1998, p. 51).

However, Posner et al. (1982) concede that students' prior conceptions are a necessity to conceptual change. Carr, Barker, Bell, Biddulph, Jones, Kirkwood, Pearson and Symington (1994) also concede to the importance of learners' pre-instructional conceptions to learning as evidenced in the following quote "then teaching needs to interact with these ideas, first by encouraging their declaration and then by promoting consideration of whether other ideas make better sense" (p. 164). Posner et al. (1982) identify two forms of conceptual change: assimilation and accommodation. According to Posner et al. (1982), assimilation refers to "the use of existing concepts to deal with new phenomena" and accommodation involves "replacing or reorganizing the learner's central conceptions" (p. 212). Accommodation entails abandonment of a learner's current conceptions in favour of new conceptions.

Research literature (e.g. Duit & Treagust, (2003); Posner et al., (1982)) points out that it is not automatic that learners change their pre-instructional conceptions after science classroom instruction. The notion by Duit and Treagust (2003) that "students already hold deeply-rooted conceptions" clearly demonstrates that learners do not simply abandon their pre-instructional conceptions and embrace the new conceptions encountered during the science classroom instruction. Conceptual change, through assimilation and accommodation is a process that

requires certain conditions to be met before one can even begin to anticipate that learners will embrace the required scientific conceptions.

Posner et al. (1982) identify four fundamental conditions for conceptual change to take place, namely: dissatisfaction with one's current conception, determined by the extent to which the new conception is considered intelligible, plausible and fruitful. According to Posner et al. (1982), the first crucial step towards conceptual change is dissatisfaction with one's current conception to deal with new phenomena encountered in the science classroom. In their own words "before an accommodation will occur, it is reasonable to suppose that an individual must have collected a store of unsolved puzzles or anomalies and lost faith in the capacity of his current concepts to solve these problems" (p. 214). The learner's realisation of the inconsistencies between their way of thinking and new conception that causes failure to solve problem confronting them may persuade the learner to accommodate the new conception provided it is intelligible, plausible and fruitful.

The new conception is deemed intelligible if it makes sense to a learner and that the learner can then find the conception sufficient enough to restructure his/her prior experiences. For a new conception to be deemed plausible, it "at least appear to have the capacity to solve the problems generated by its predecessors" (Posner et al., 1982, p. 214). A new conception can then be deemed fruitful if "it should have the potential to be extended, to open up new areas of inquiry" (p. 214). In other words, the new conception should fit into a learner's way of thinking so that it could be applied to new situations and yield new outcomes. According to Posner et al. (1982) a plausible conception must first be intelligible, and a fruitful conception must be intelligible and plausible. Furthermore, they postulate that the extent to which a particular learner deems a new conception intelligible, plausible and fruitful is dependent on the learner's 'conceptual ecology" or learner's existing knowledge (Hewson, 1992). Therefore, one learner

might find a new conception to be intelligible, plausible and fruitful while another learner may not. One's conceptual ecology is affected by a number of factors that include anomalies, analogies and metaphors, epistemological commitments, metaphysical beliefs and concepts, and knowledge in other fields. At this juncture, I would also propose that one's language proficiency impacts on one's conceptual ecology. A learner may fail to select a new conception as intelligible, plausible and fruitful due to failure to interpret correctly the meanings of words and phrases used during instruction of new scientific concepts.

2.6 The role of language in learning

The importance of language in the construction of meaning in learning in general, and in particular science learning has long been recognised (Oyoo, 2012). Language is considered an important part of scientific literacy (Fung & Yip, 2014). Scientific literacy simply means one is able to read and write scientific texts. Fung and Yip (ibid) contend that scientific literacy leads one to be in a state of "being knowledgeable, learned, and educated in science" (p. 1220). One can only be scientific literate if one is proficient in both the language of science and science concepts.

Michael (1952) cited in Okebukola, Owalabi and Okebukola (2013) say that "language shapes thoughts and emotions, determining one's perception of reality and that language is the light of the mind" (p. 63). Learning entails individual construction of knowledge depending on one's perception of reality. The quote illustrates that language is crucial in cognition. Nesher (1987) contends that learning begins with the meaning of words and phrases used in the classroom. Once learners understand the meanings of words and phrases (language), then the learners can use the language to call up representations of experiences that they associate with particular words and phrases as they engage in the meaning making process. In this way language is, therefore, necessary in reformulation of thought processes leading to accommodation.

Language is then a necessary tool that allows meaning to be conveyed and created during the teaching and learning process. Okebukola et al. (2013) as a way of demonstrating the importance of language in learning has this to say about language in learning "the science classroom is barren without language" (p. 64). The absence of language, oral or written, prevents the teacher from presenting science concepts to learners, and the required intentional meaning making process that results in learning will not occur without language. It is reasonable then to conclude that without language there is no learning, hence no transmission of knowledge. Again this brings to the fore that language is crucial in learning to the extent that we can conclude that language is knowledge.

Every subject has its own special language used for teaching and learning. Gee (2004) contends that particular groups have various ways of using language specific to that group. As such, science has its own specific language different from any other in its vocabulary, syntax and discourse features. For learners to excel in science education, it is necessary that they are aware of these differences, so that they become proficient in the science language. According to Henderson and Wellington (1998), the greatest barrier to learning science is the language barrier. These authors contend that the thrust in science education should shift from focusing on science as a practical subject, to learning science as one learns a new foreign language, and as such, science teachers should become language teachers as well. According to Gee (2004), through a cultural process, teachers regarded as the "masters" with regards to use of specific vocabulary in science should play a significant role in teaching and learning to extend learners' language and deepen learners' conceptual understanding. An important feature of the science vocabulary is the richness of the words and terms it uses in communication. The teacher's role is therefore that of scaffolding learners and exposing them to these words and terms. When learners acquire the necessary language, they will be able to express concepts with clarity, read with understanding and construct knowledge correctly. The importance of language in learning

can never be underestimated. The following quote from Vygotsky (1978) summarises the important role of language in educational and intellectual development:

> The most significant moment in the cause of intellectual development, which gives birth to purely human forms of practical and abstract intelligence, occurs when speech and practical activity, two previously completely independent lines of development, converge (Vygotsky, p. 24).

Indeed practical activity is an integral part of acquiring scientific knowledge, during which learners manipulate and observe real objects and materials, but language is a necessary tool for development of thought in learning. Through practical activity, learners are able to gather visual evidence necessary for understanding the world around them and language is an essential tool needed for successful engagement in the practical activity. Learners use language to plan and conduct practical activity and also to analyse, interpret and evaluate the empirical data gathered through practical activity. Learners must therefore be proficient in both the language of learning and teaching (which in this case is English) and also in the context of use of language of science for meaningful engagement in practical activity. Through language learners can present their opinions and claims as they communicate scientific information, concepts and ideas accessed through practical activities. Mammino (2010), says about language that it is "an essential tool for all inquiry aspects of sciences (identifying investigation questions, identifying relationship between pieces of information, formulating and verifying hypotheses, making inferences) and in trains of thoughts leading from information to interpretation and ultimately to theory" (p. 2). The convergence of practical activity and language is then a necessity in successful science education. Language used in science classrooms enables mutual communication between teacher and learners to achieve shared meaning

Socio-cultural constructivists view learning as an active process during which learners socially interact and collaboratively construct knowledge and make sense of the world around them

under guidance of a teacher. Social interactions occur through language. According to Jones and Brader-Araje (2002), "Vygotsky argues that language is first interpersonal, between the child and the external world, and then becomes intrapersonal" (p. 5). This quote suggests that children learn language from individual(s) in their external world who are already conversant with the appropriate language used for social interactions. In the science classroom (which can be considered the external world), the science teacher as the person who is proficient in the language of science has the ultimate responsibility of exposing the learners (children) to the language of science through use of quality classroom language. The transformation of language from the interpersonal plane to the intrapersonal plane occurs through the process of internalisation. Wertsch (1985) defines internalisation as "a process whereby certain aspects of patterns of activity that had been performed on an external plane come to be executed on an internal plane" (p. 61). Through social mediation by the science teacher, learners first learn the language of science in the classroom before they can internalise the meanings of words used in the classroom. The learners will then use the internalised language, which can be referred to as internal speech, to construct knowledge resulting in science learning.

To add to the quality of internalised language, teachers may also use their oral language to initiate I-R-F interactions in the science classroom. Such patterns of interaction assist learners to explore and share their own views and also provide learners "opportunities to practice the social skills of communicating and collaborating" (Henderson & Wellington, 1998, p. 36). Teachers use their oral language to assist learners to participate meaningfully in these interactions thereby facilitating the ZPD of learners in terms of language acquisition and hence learning. Therefore, the teacher's classroom language is a necessity for social interactions, internalisation and social mediation in zone of proximal development (Leach & Scott, 2003; Msimanga & Lelliot, 2012). It is reasonable to conclude that the success of the above

mentioned variables which influence science learning is dependent on the quality of the teacher's classroom language, and the extent to which learners comprehend the teacher's talk.

Through their classroom talk, teachers guide their students into the science discourse so that learners can begin to think, write and talk using the correct language of science. According to Nesher (1987), teachers use language to orient or guide the students' conceptual activity in the desired direction in order to achieve the desired outcomes. I take this to refer to scaffolding through probing done by a teacher to guide learning and reduce distractions. However, Nesher (1987) contends that as teachers orient the conceptual construction of learners, they should have an idea of what goes on in their learners' heads, and concludes with the following quote "in order to teach one must construct models of those who happen to be students" (p. 45). In terms of language, I interpret this to mean that a teacher must use simple language that learners would understand more easily and avoid using big and complicated words that learners may not understand at all. Use of simple language that is to the level of learners would go a long way in assisting learners to construct correct mental models of the concepts being taught. The teacher's classroom language has a deep impact on the classroom language, in general, and in particular, on the learners' language and hence determines whether the learning of science will be successful or not. The following quote by Azian, Raof, Ismail, and Hamzah (2013) summarises the pivotal role of a teacher's oral instructional language in the science classroom, "teacher's oral language which takes place in a pedagogic context is at the heart of teaching and learning" (p. 283). Therefore a good content knowledge on its own is insufficient to make a good teacher. The teacher must also have the necessary language to impart science knowledge to his/her learners

2.7 The Language context in South Africa

South Africa is a rich culturally-diverse sub-Saharan country that has 11 official languages.

Table 2.2: Speakers of different Languages in South Africa

Language	Speakers	(%)
Zulu	10 677,000	23.8
Xhosa	7, 907,000	17,6
Afrikaans	5,983,000	13.3
Northern Sotho	4,209,000	9.4
Tswana	3,677,000	8.2
English	3,673,000	8.2
Sotho	3,555,000	7.9
Tsonga	1,992,000	4.4
Swati	1,194,000	2.7
Venda	1.022,000	2.3
Ndebele	712,000	1.6
Other languages	217,000	0.5
Total	**44,820,000**	**100.00**

Source: Statics South Africa, 2001, p. 11

The Language in Education Policy (LiEP), allows teachers and parents to choose any of the official languages as a language of teaching and learning (LOTL). Despite this policy, teaching and learning in South Africa is primarily conducted in English .This is due to the "perception that English provides access to education and employment", (Probyn, 2005, p. 1858). Oyoo (2012) concedes to this reasoning in his argument that " in the African countries where English, French, and Portuguese are already the languages of formal education, it is apparent that they may continue to be used at all professional and academic levels because of their global presence and attractiveness in international communication" (p. 104). It is reasonable then to assert that regardless of the LiEP, English will continue to be a language of choice for teaching and

learning in many South African schools. The Department of Education report of 2010 (DoE, 2010) states that, by 2010, English was the most favoured language of instruction, used by 81.55% of FET learners. Relative usage of Afrikaans as a language of classroom instruction is shrinking, and is reported to be used by only 6% of FET learners. The indigenous (mother tongues) languages spoken by most native South Africans are only used as languages of classroom instruction during the early stages of primary school (from grades 1 to 3) (Ferreira, 2011).

The fact that most learners in South Africa do not use their home language for learning presents a huge challenge. Brock-Utne (2014) suggested that this is because the language used for instruction is a language "neither pupils nor teachers master well and do not normally speak outside school" (p .4). The science teacher as the person having trained to teach science in the English language is expected to have a better proficiency in the language of instruction regardless of the fact that it is most likely not the teacher's mother tongue. So the teacher has the burden of ensuring their learners become proficient in both the language of instruction, in general, and in particular the language of science. If teachers are not vigilant with how they use the oral language to assist learners understand the science concepts being taught, then it will be like "sowing seeds on rocky surface" as stated by Fafunwa, Macauley, and Soyinka (1989) cited in Okebukola et al. (2013). Simply put, no learning or very little learning will occur in these science classrooms.

With the foregoing, the important role of the science teacher's oral language in learning can never be overstated. This is of special importance to the study since the language of instruction in most cases is not the first language of neither the teacher nor learners.

2.8 How to Address the Language Problem in the Science Classrooms

As discussed, the fact that science learners have a general difficulty with the language used in the classroom is also highly applicable in the South African context. Teachers should then try their utmost best to assist learners acquire the appropriate language that will enhance learning.

Literature (Oyoo, 2011; Schoerning, 2014) concede that teachers' linguistic interventions are necessary in enhancing students' acquisition of discipline specific language, and hence enhance understanding of science concepts. The teachers' linguistic interventions are necessary regardless of whether learners are first or second English language speakers.

Use of vocabulary familiar to students as a means of familiarising students to the unfamiliar (foreign) scientific terminologies is a key aspect of assisting learners gain proficiency in the language of science. Schoerning (2014) recommends linguistic intervention through use of familiar vocabulary or plain English in science classes to enhance understanding of unfamiliar science terminologies, which she refers to as Anglicization. Schoerning's (2014) inference that Anglicization improves students' ability to analyse and apply knowledge is a significant confirmation of the importance of use of everyday language in enhancing comprehension of science concepts

Oyoo (2011) posits that teachers should explain the contextual meanings of everyday words when they are used in a science context so that learners do not apply the everyday meanings in science. Explaining contextual meanings of non-technical words will prevent misconceptions that may arise due to polysemy of these words.

Haug and Odegaard (2014) hypothesize that promoting word knowledge helps in acquisition of the correct social language of science. The authors posit that students must be taught in such a way that they have active control of words. Haug and Odegaard (2014) are of the view that

active word control "involves understanding words in context and in relation to other words within the discipline" (p. 780). Understandings words and their relationship to other words helps in achieving what Haug and Odegaard (2014) refer to as "conceptual understanding". Therefore, it's not sufficient to teach meanings of words in isolation but words should also be "taught as concepts connected to other concepts to form rich conceptual networks" (p. 780).

Scott, Mortimer and Ametller (2011) recommend that science teachers make use of link-making strategies to enhance conceptual understanding. I also concur with this notation that science teachers make use of pedagogical link-making words to support knowledge building as suggested by Scott et al. (2011). This link-making process encourages teachers to integrate and differentiate everyday and scientific ways of explaining phenomena. My premise is that learners can only be in a position to integrate and differentiate everyday meanings and scientific meanings when they acquire correct contextual meanings of everyday words used in the science context. Again this shows the need to provide the contextual meaning of everyday words used in a science context. Providing contextual meanings of such words assists in addressing most of the science learners' pre-instructional conceptions. Learners' pre-instructional conceptions are related to their understanding and usage of everyday language as evidenced in the following quote "everyday language is connected to typical and well known pre-instructional conceptions informed by everyday experiences" (Rincke, 2011, p. 234). Rincke (2011) exemplifies this need using the word *'force'*. Learners' pre-instructional conception of *'force'* is that *'force'* has a property of a single object, for example "she is a very forceful person" (p. 235). In a science context however, *'force'* expresses an interrelation between at least two objects. Therefore, through link making, learners can be assisted to reformulate meanings of everyday words used in a science context from their informal everyday meanings to more scientific meanings.

Oyoo (2011) refers to some aspects of the teacher's language that may compound the science language challenge instead of addressing this challenge. These aspects include speed of talking and pronunciation, audibility and teacher's language level (vocabulary). Teachers should avoid talking fast and inaudibly while teaching. Teachers should also ensure that words are pronounced correctly. It is a prerequisite that teachers have a high level of vocabulary (both technical and non-technical) if they are to successfully initiate learners into the language of science.

2.9 Chapter Summary

In this chapter, the theoretical and conceptual framework that guided the study was discussed. Vygotsky's (1978) socio-cultural constructivism is the learning perspective adopted in this study which recognises the importance of language in learning. Hence, the argument by Postman and Weingartner (1971) on page 12 was adopted as the conceptual framework of this study. A review of the literature shows that learning science involves conceptual change of students' pre-instructional conceptions to new conceptions that are compatible with scientific knowledge, provided learners find the new conceptions intelligible, plausible and fruitful. But as Postman and Weingartner (1971) argument shows, language acquisition is a necessity in understanding science knowledge leading up to conceptual change. A review of literature shows that the teacher's classroom language is made up of technical and non-technical words, and that physical science learners find the entire science language difficult. Some of the difficulties encountered by science learners with the science language are highlighted.

The role of the physical science teacher's classroom language in learning is discussed. Some linguistic interventions that physical sciences teachers can use to assist learners acquire science language are also discussed, such as, Anglicization, explanation of meanings of both technical and non-technical words used, making use of link-making words and teaching learners to have active control of words.

The next chapter discusses the overall research approach, data collection method, sampling of participants, and how the study was conducted.

Chapter 3: METHODOLOGY

3.1 Introduction

This study focuses on how South African physical sciences teachers use their oral classroom language to enhance understanding of the science concepts being taught in the science classrooms. First, the research questions this study seeks to answer are restated.

1. How are South African physical science teachers using oral language during teaching to assist learners understand science concepts?
2. What other factors contribute to observed teachers' language use styles?

The following aspects of the study are discussed in this chapter: overall research approach, methods of data collection used, research context, sampling of participants, the actual study, and data analysis strategy. First, l discuss the overall research approach.

3.2 Research Methodology

The overall research approach used is the qualitative case study approach. Gerring (2004) defines a case study as "an intensive study of a single unit for the purpose of understanding a larger class of similar units" (p. 2). Baxter and Jack (2008) have also defined qualitative case study as "an approach to research that facilitates exploration of a phenomena within its context using a variety of data sources" (p. 544). Joubish, Khurram, Ahmed, Fatima and Hauder (2011) also define a case study as "an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem" (p. 2083). From all the definitions, I prefer the one by Baxter and Jack (2008). The case study approach offers an in-depth analysis of the case under investigation in its natural context without a lot of intrusions that may affect the outcomes of the research.

Cohen and Marion (1995), Gerring (2004); as well as Punch (2009) have identified a number of characteristics of a case study. Some of these characteristics are that, a case study has boundaries, uses multiple sources of data and multiple data collection methods, and occurs in

a naturalistic setting. Case studies use field methods such as direct observations in natural settings, interviews, narrative reports, and may also use questionnaires (Punch, 2009), to collect data. Yin (2003) cited in Baxter and Jack (2008) refers to circumstances under which the case study approach can be used. Two of those conditions are applicable to this study. Yin (2003) cited in Baxter and Jack (2008) proposes that a case study can be used when "the focus of the study is to answer "how" and "why" questions" and also when the research "cannot manipulate the behaviour of those involved in the study" (p .545). As already stated, the study sought to find out how physical science teachers use oral instructional language to enhance understanding of science concepts by their learners. This and the fact l was a non-participant observer, makes the case study approach an appropriate method to find answers to my research questions. Based on these characteristics, the case study approach was chosen above others like survey and action research, because the study targeted a small sample.

Only two physical science teachers from two South African high schools were involved in this study. The study involved a small number of respondents, making it easy and inexpensive to use. The study also allowed for purposive sampling of participants that are information rich and illuminative as they offered useful manifestations of the research problem.

The disadvantage of a case study is that findings of a single case study may fall short in their representativeness. In this regard there is need to carry out many studies through case studies or other methods to get findings that are a true reflection of the situation in a population with regards to the problem being investigated in a study. In view of this, it may be difficult to generalise findings of this case study to all South African physical science teachers. However, according to Gerring (2004), findings of a case study may be generalised to a larger class of similar units that have unit homogeneity with the case and therefore are comparable. Punch (2009) also concedes that case studies can produce potentially generalizable results through

conceptualizing and developing propositions. Punch (2009) attests to the fact that through conceptualisation, the researcher develops one or more concepts to explain some aspect of what has been studied, through an in-depth study that is only possible in a case study. A researcher may also develop propositions or hypotheses that can be applicable and transferable to other situations. For this reason, it is possible to apply findings in a case study to all other members in a population if they are homogenous to the case used. In case of this study, this would be with regards to the instructional language used in teaching science.

3.3 Methods of data collection

As stated in section 3.2, several methods can be used for data collection as per research questions in a case study, including questionnaires and interviews. Naturalistic direct observations and follow up interviews were considered as data collection methods in this particular case study, as now explained

3.3.1 Naturalistic Direct Observation

I start by giving a brief discussion of direct observational research. Opie (2004) refers to observation as a planned and systematic way of gathering information. Opie (2004) points out that observational research cannot be conducted in a spontaneous and haphazard way. Best and Kahn (1998) also concede to this notion, saying "observation is carefully planned, systematic, and perceptive" (p. 298). The researcher needs to know in advance what she or he is looking for. In this study l was particularly looking at how participant science educators are using their oral language to enhance understanding of physical science concepts by the science learners they are teaching. To a certain extent, knowing what information one is looking for, what information is relevant or irrelevant to the study, helps minimise distractions on the part of researchers by setting boundaries within which the research is conducted.

In naturalistic direct observational research, the researcher goes to the research site to gather information of what is actually taking place; what Bertram and Christiansen (2014) refer to as first-hand data as opposed to getting information from someone else. Therefore, the lesson observations enabled me to get information first-hand as alluded to Bertram and Christiansen (2014) instead of relying on someone's words. According to these authors, direct observation of research site will also enable the researcher to see things that participants might not reveal in interviews. This afforded me the opportunity to obtain a deeper understanding of information being investigated as I was also in a position to get data that I might not access from teachers if l had only interviewed them on how they use their oral language to enhance understanding of science concepts in the science classroom. By visiting the research site, the researcher has an added advantage of observing the participants in their natural settings (contexts), as evidenced in this quote from Best and Kahn (1998), "using the method of observation, the researcher observes, listens to, and sometimes converses with the subjects in as free and natural an atmosphere as possible" (p. 252). Therefore, observing participants in their real-life settings might reduce or minimise a change in the normal behaviour of participants than would be the case if the participants were moved to another or unfamiliar environment.

However, literature has also identified several limitations of direct observation as a data collection method. One disadvantage of direct observation as detailed by Bertram and Christiansen (2014) is that what a researcher decides to focus or record and how she or he interprets the data depends on her/his view of the world and what she/he expect to see. Cohen and Marion (1995) also attest to the same notion as evidenced by this quote, "the accounts that typically emerge from observations are often decried as subjective, biased, impressionistic, idiosyncratic ..." This means that different researchers can interpret the same observations differently, which may raise questions of validity in observation-based research. Another disadvantage as stated by Bertram and Christiansen (2014) is that human interactions are

complex and are affected by previous experiences that the researcher is not aware of. This may result in the researcher failing to interpret correctly the meaning of some interactions observed in a particular situation. It is also possible for a researcher to misinterpret the behaviours of the participants. Observation, on its own, may not be sufficient for the researcher to correctly interpret behaviour of participants without seeking further explanations for such behaviours as in the case of interviews. The difficulty lies in the fact that the observer should not only be able to observe and interpret behaviours from his or her own perspective but should also be able to get inside the minds of the participants so that he or she can also interpret in terms of the participants themselves (Best & Kahn, 1998). In this study, interpretation of observed behaviours was solely done from my perspective. I did not member-check transcripts of classroom observations and interview with participant teachers to see if l represented them well.

Observation of human behaviour is to some degree an intrusion into the dynamics of the situation. This intrusion may result in the participants consciously or unconsciously altering their normal behaviour (Bell & Kahn, 1998; Bertram & Christiansen, 2014; Opie, 2004). Bertram and Christiansen (2014) refer to this effect as the Hawthorne Effect, which can be called the human factor. Lastly, Opie (2004) posits that observation is time consuming. The naturalistic direct observations served the purpose of collecting data that can be used for contextual description of the participant educators and their use of oral instructional language as tool for enhancing learning. The following are some of the concerns addressed during the direct lesson observations conducted in my study, some of these were adopted from Oyoo (2012, p. 861).

- Does the teacher provide the meaning of everyday (non-technical) words when they are presented in a science context?
- Does the teacher provide meaning of science specific (technical) words used in the lesson?

- Does the teacher use their classroom language to initiate teacher-learner and learner-learner dialogue, or the classroom talk is dominated by teacher talk only?
- What other factors of the teacher's classroom language may act as barriers to shared meaning of words used in the classroom such as pronunciation and audibility?

3.3.2 Interview

Maree (2007, p. 87) defines an interview "as a two-way conversation in which the interviewer asks the participant questions to collect data and to learn about the ideas, beliefs, views, opinions and behaviour of the participant". An interview as a method of collecting data aims at obtaining rich data that helps the researcher to understand the respondent's construction of knowledge and reality. Punch (2009, p.144) describes how:

> **in order to understand other persons' construction of reality, we would do well to ask them....and to ask them in such way that they can tell us in their terms (rather than those imposed rigidly and a priori by ourselves) and in a depth which addresses the rich context that is the substance of their meaning.** (Bold in original text)

Therefore, the specific purpose of an interview is to ask the questions whose answers are relevant to the study, and not just a mere conversation. Interviewing can be in form of individual face-to-face, or face-to-face, or telephonic verbal exchange (Punch, 2009).

There are different types of interviews, viz, unstructured, semi-structured, and structured. In unstructured (open-ended) interviews, participants are not required to answer a set of predetermined questions, while participants are required to do so in semi- structured and structured interviews. The difference between structured and semi-structured interviews is that probing and clarification of answers are possible in semi-structured but not in structured interviews. .It is important that the interview data is captured for use during analysis (Punch, 2009). Recording methods include audio recording, video recording and note taking.

The disadvantages of interview as a data collection method include the fact that it is time consuming to conduct the interview itself and to transcribe the interview data.

Unstructured interviews were used in this particular study with the participant educators. Unstructured interviews were used so as not to limit the scope of the discussion around teachers' expressed ideas on the role of their oral language in successful science learning. Follow-lup questions then emerged as the interview progressed depending on the direction of the interview. Educator interviews also assisted in filling in the gaps in some of the non-verbal behaviours of interest that occurred during the lesson observations.

3.4 Research Context and Sampling of Participants

3.4.1 The physical science teachers in South Africa

This study focused on South African physical science teachers' use of oral language during teaching. In South Africa, physical science teachers are a mixture of locally trained teachers and foreign teachers from other countries. The pool of local South African teachers consist of both qualified and unqualified teachers (Mji & Makgato, 2006). Most of the foreign teachers come from other African countries such as Zimbabwe, Nigeria and Malawi. The recruitment of foreign teachers has been necessitated by the lack of appropriately qualified science teachers in South Africa.

The foreign teachers hold an array of different qualifications obtained in their home countries. However, it is mandatory that these foreign qualifications are first verified by the South African Qualifications Authority (SAQA) and also by the Department of Basic Education to assess if the teachers are professionally qualified to teach science in South Africa. The verification of a teacher's foreign qualifications is a necessity for registration with the South African Council of Educators (SACE), which gives teachers permission to practice in South African schools. Therefore, it can be said that all foreign teachers teaching science in South African are appropriately qualified to teach science. It is however, important to note that the South African population of science teachers is made up of teachers that are mostly speakers of English as a

second language speakers (both local and foreign teachers). It is hoped that the training of these teachers has given the teachers sufficient linguistic confidence to assist learners acquire science language proficiency necessary for comprehension of science concepts. Two physical science teachers from this pool of teachers consented to participate in this study; they were considered representative of the South African population of physical science teachers.

3.4.2 Sampling of Participants

Maree (2007, p. 79) defines sampling as "the process used to select a portion of the population for study". Sampling of participants involved in this study used a combination of purposive and convenience sampling strategies. Convenience sampling involves choosing the nearest individuals to serve as respondents (Cohen & Marion, 1995). Purposive sampling involves deliberately selecting participants that meet criteria relevant to the research study.

The participants chosen in this study met the criteria relevant to the study. The participant teachers were selected on the basis that they are physical science teachers in South African high schools. Their respective learners became participants in the study by virtue of being students in the participant teachers' classrooms**.** Initially four physical science teachers had agreed to participate in this study but two of them withdrew from the study at the last minute. One of the participant teachers was observed while teaching a grade 11 class and the other teacher was observed teaching a grade 10 class. Therefore, only grades 10 and 11 physical science learners were participants in this study. The schools that participated in the study were selected on the basis of the schools' general performance in physical science at Further Education and Training (FET) level (grade 10, 11, and 12).

3.4.3 Sample details

One of the two schools is a former model C school (herein referred to as school A), and the other is a previously disadvantage township school (herein referred to as school B). School A

is located in the West Rand of Johannesburg. The school's student population comprises of learners from different marginalised ethnicities, namely Blacks, Indians and Coloureds. The learners come from different socio-economic backgrounds of South Africa. The school has an enrolment of more than 1000 learners, consisting of both girls and boys. The average number of FET physical science learners per class is 30. The medium of instruction in school A is English. The school's grade 12 performance in physical science for the last three years averaged at 70% but the Head of Department (HOD) expressed concern with high failure rates at grades 10 and 11.

School B is a township school located in the sprawling Alexandra Township also in Johannesburg. The school population comprises of only black South African learners. The student enrolment in school B stands at about 1500. FET classes at school B are much larger than in school A with an average of 45 learners per class. The average percentage pass rate for matric physical science examinations for the past three years ranges between 55- 60%. The HOD of this school also expressed concern with high failure rates at grades 10 and 11. The language of teaching and learning at school B is also English.

The two participant physical science teachers are teaching at the two high schools located in the Gauteng Province. For purposes of maintaining anonymity and confidentiality, the teacher at school A is referred to as Teacher A, while the one at school B is referred to as Teacher B. Teacher A is a black South African qualified science teacher, with 22 years of teaching experience. Teacher A's highest qualification is a Bachelor of Science (B. Sc.) Honours in Physical sciences from a highly reputable South African university. Teacher B is a qualified foreign science educator from an African country. Teacher B has a B.Sc. Degree and also completed a post graduate certificate in education. Both teacher A and Teacher B are not

English first language speakers. Teacher A was observed teaching a grade 11 class, while teacher B was observed teaching a grade 10 class.

3.5 Conducting the study

3.5.1 Accessing the research sites

First, permission to conduct the study was sought from the Gauteng Department of Education under whose jurisdiction the schools fall since they are public schools. A letter of approval (Appendix 1) was issued after submission of the application form to the Gauteng Department of Education head offices in Johannesburg. After approval of my ethics application (Appendix 2) by the Wits University's Ethics committee, I then requested permission from the principals of the targeted schools to conduct my research study at these schools.

Although two separate schools were involved in this study, the procedure followed to access these schools was exactly the same. What follows is the general discussion of what transpired in order to seek permission to conduct study from the principals of the schools.

I went in person to the two schools to request permission from the principals of these schools. I handed the request letter (Appendix 3) to each of the two principals. This was then followed with a brief description of the intended study. I told the two principals of the purpose of the study, its aims and the research questions the study sought to answer. Both principals verbally accepted my request to conduct the study at their respective schools, and both showed a lot of enthusiasm in my intended study and were hopeful that the study will impact positively on the teaching and learning of physical sciences in their schools. They expressed their concern with the general performance in physical sciences, and both principals conceded that language could be a contributing factor to the status especially considering the fact that most of the learners were from homes where English is not their mother tongue.

After meeting the principals, l then met with the respective Head of Science Department of each school who l then briefed about my study. This was then followed with a meeting with the physical science teachers at each school. After the introductions and briefing on the study, I then gave each of the physical science educators the information sheet (Appendix 4) requesting their voluntary participation in the study by allowing me to observe and video record, at least, three physics lessons per participant teacher. Coincidentally, two teachers in each of the two schools agreed to be participants in the study. We then agreed that l would observe grade 11 physics lessons of the two teachers at school A and grade10 physics lessons of school B teachers. The four teachers were then requested to sign the teacher's consent form giving their permission to lesson observations and also to video recording during the lesson observations (Appendix 5). Two of these four teachers who initially expressed interest to participate in the study later withdrew from the study.

Although the participant teachers' respective learners were not directly involved in the study still they are considered participants when data collection is done through direct observation of classroom lessons. Therefore l had to meet up with the participant teachers' respective learners. I then briefed the learners about my study and also gave each of the learners an information sheet (Appendix 6) that summarised the purpose of the study. All learners agreed to participate in the study. The learners above 18 years of age were requested to sign consent forms to participate in the study and to be videotaped (Appendix 7).

All other learner participants that indicated that they were below 18 years of age were given information sheets and consent forms (Appendices 8 and 9) to give to their parents so that they could grant the learners permission to participate in the lesson observations and also give permission for video recording during those lesson observations. All the parents of the minor learners granted permission allowing the learners to participate in the lesson observations and

also for video recording. A timetable was set up for when l could visit the two schools to observe physics lessons and also to do follow-up interviews with the participant teachers.

3.6 The Data Collection Process

3.6.1 Naturalistic Direct Observation of lessons

As already stated, non-participant naturalistic direct observation was used as the data collection method. I went into physics science lessons to video-record the lessons. I also made field notes during the direct lesson observations. All learners agreed to video-recording so no learners were left out during the video-recording process. The videos were then transcribed verbatim. The transcripts (Appendices 10 and 11) were then used for data analysis.

3.6.2 Educator Interviews

One participating physical science educator was interviewed as a follow-up to the lesson observations. The interviews were conducted in privacy, behind closed doors to maintain confidentiality. The purpose of the educator's interview was to find out the educator's views on the importance of the teacher's oral instructional language in the teaching and learning of physical science. The interviews also sought to find out from the teacher how he is assisting his learners, through use of oral instructional language, to get a better understanding of the science concepts taught. The educator's interviews were conducted after the video recordings of the lesson observations were transcribed.

The educators' interviews were unstructured face-to-face, individualised interviews so as facilitate follow-up of teachers' utterances through probing. However, questions were used to kick start the interviews. The questions were meant to get relevant information for the study. Further questions were asked depending on how the interviews progressed. Some of the questions asked to the participant educators are listed below.

1. Do you think science learners have a problem with language in science?
2. Do you think language used in science is different from everyday language, for example English in general?
3. Do you explain the meanings of everyday words presented in a science context?
4. Do you think science teachers contribute to the misunderstanding of words used in the science classroom?
5. How best do you think the language problem can be addressed?

The questions posed to the participant were necessitated by the need to obtain an in-depth understanding of the educators' train of thoughts on the role of language in science learning and concerns already highlighted above. The educator interviews were successfully conducted and provided information relevant to the research questions of the study. The educator interviews were also video recorded. The videos were later transcribed verbatim. The interview transcripts (Appendix 12) were also used for data analysis.

3.7 Exiting the research site

There were no major challenges encountered in accessing the two research sites. The principals showed a lot of interest in the study, and both were very optimistic that the study will go a long way to sensitize the participant physical science teachers to the crucial role of language in the successful teaching and learning of science. The lesson observations were generally not problematic. However, at sometimes, there were learners within the vicinity of the classroom where the lessons were being conducted who made noise resulting in poor audibility of the videos. Therefore, a lot of time was spent playing the videos several times during the transcription process.

3.8 Analysis of Data

Data was obtained from direct lesson observations as lessons were presented by the participant educators, and also from the educators' interviews as already outlined. Data was also obtained from the field notes made during both the lesson observations and educators' interviews. The videos from the lesson observations were transcribed verbatim. Verbal data obtained through

interviews of participant educators were also transcribed verbatim. The two data collection methods used in this study produced verbal data (qualitative text) only. There was no numerical data produced.

Content analysis was deemed suitable for analysing the qualitative data collected in the study. Mayring (2000) defines content analysis as an "approach of empirical, methodological controlled analysis of texts within their context communication" (p. 2). Mayring (2000) further states that the object of content analysis "can be all sort of recorded communication (transcripts of interviews, discourses, protocols of observations, video tapes, documents" (p.3). Therefore, content analysis was deemed suitable data analysis strategy in this study because transcripts of lesson observation and educators' interview videos were the objects of analysis in this study. The type of content analysis used in the data analysis is interpretive content analysis. A more detailed analysis of the qualitative text data obtained in the study is presented in chapter 4.

3.9 Chapter summary

In this chapter, a discussion of the overall approach (the qualitative case study approach), used in this study was presented. Naturalistic direct observation and interview were used as the data collection methods. A brief description of physical sciences teachers in South African was also given. Sampling of participant teachers (using purposive convenience sampling), sample size, ethical procedures, and challenges faced in conducting the study were also discussed.

In the next chapter, the actual data analysis is presented and findings discussed.

Chapter 4: Data Analysis and Findings of the Study

4.1. Introduction

In this chapter, the analysis of the data is presented and the findings discussed. First however, the questions this study sought to address are revisited:

1. How are South African physical science teachers using oral language during teaching to assist learners understand science concepts?
2. What other factors contribute to observed teachers' language use styles?

The raw data in this study was collected using naturalistic direct observations of physics lessons and follow-up individual face-to-face interviews of the participant physical science educator. The lesson observation videos and educators' interview audio recordings were transcribed verbatim. I also watched the videos of the lesson over and over again so that l do not miss any non-verbal communication that occurred during the lesson that maybe relevant to answering the research questions of my study. The transcripts texts were then analysed using content analysis with interpretive analysis being the main form of content analysis used. The transcripts text were analysed to find out how the participant educators' oral language was used to address the following concerns or issues (adopted from Oyoo, 2012) relating to the study.

1. Communication pattern used during the lesson delivery.
2. Explanation of both technical and non-technical words used in the lessons, and differentiating between everyday meaning and science contextual of non-technical used
3. Is language used at the level of learners?
4. Other practices used by the teacher that could facilitate or hinder successful learning of science.

What follows is the analysis and discussion of findings from both the lesson observations and educators' interviews. The actual names of participant physical science educators were not used in the analysis and discussion of findings to maintain anonymity and confidentiality. To reiterate, the participant educators have only been referred to as Teacher A and Teacher B.

4.2 Analysis and discussion of findings of the study

4.2.1 Analysis and discussion of findings from the lesson observations

Teacher A was observed teaching electric circuits lessons. Three lessons were observed and video recorded. The lessons were conducted in one of the school science laboratories. The choice to observe these lessons was deliberate for the following reasons. Firstly, the topic on electric circuits is one of the main topics on which learners are examined in their grade 12 final paper 1 physical science examinations. In order to improve the learners' chances of passing the physical science paper 1 examination and eventually the physical science matric examinations, it is imperative that learners perform well in this section of the examination. Secondly, the topic on electric circuits is only taught at grades 10 and 11 levels. No time has been allocated in grade 12 for teaching of this topic. The learners are, however, expected to revise this section in readiness for their final examinations as stated in the CAPS document. This then brings the need to teach this topic thoroughly at both grades 10 and 11 levels to ensure learners get a good grip of the core concepts in this section sufficiently enough to take them to grade 12. Learners have many new concepts to deal with at grade 12 and may not have enough time to revise this section.

I also deliberately chose to observe Teacher B teaching the topic on mechanics that introduces grade 10 learners to linear motion of objects. This introductory section of mechanics contains a lot of new concepts that learners have not been exposed to at grades 8 and 9 as it does not form part of the natural science syllabus. Definitions of fundamental concepts in linear motion in one dimension such as displacement, velocity and acceleration are first introduced to learners at grade 10 level. Learners are then expected to apply knowledge of these concepts in grade 11 when they learn about Newton's Laws of motion in grade 11 and also in vertical projectile motion in grade 12. It is crucial then that learners are taught with understanding the main science concepts that make up this introductory section to linear motion. Understanding of this

introductory section will help learners to be in a better position to understand the build-up on topics in mechanics in grades 11 and 12. This is important because the mechanic sections form the main component of assessment in physical science paper 1 examination papers at all FET levels (grades 10, 11 and 12).

4.2.2. Communication pattern used during the lessons

Teacher A tried by all means to engage his learners in the conversations occurring during the lessons. The excerpts immediately below are evidence of the many instances in which Teacher A tried to engage his learners in the ongoing classroom conversations

> **Teacher A:** *Right but aah, l have got two things to mention on for example here. What is missing in this data? Let's say, look at this. What is missing there?*
>
> **Learners:** Chorus something inaudible
>
> **Teacher A**: *What is the relationship between I and R?*
>
> **Learners*:*** *Inversely proportional*
>
> **Teacher A:** *No. So why are they the same here Mosa?* (Not learner's real name).
>
> **Mosa:** *Because the resistors are equal*
>
> **Teacher A***: Total, so how do you find the total resistance, resistance there?*
>
> **Learner:** Says something inaudible

Most of the questions asked by Teacher A as a way of engaging learners in the classroom conversation were either not answered or learners spoke in low tones that were too soft to be heard clearly. Probably the learners felt uncomfortable in the presence of the researcher or were simply afraid of giving wrong answers to questions posed by the teacher. Regardless, Teacher A still continued to encourage his learners to engage in the classroom conversations as demonstrated by the next excerpt

> **Teacher A**: *Let's speak up guys. Let's not be shy. It doesn't matter whether you make a mistake. Remember I always say eeee we learn by making mistakes.*

Teacher A also tried to engage his learners in the lesson conversation by letting learners complete some of his sentences as demonstrated below.

> **Teacher A:** *The higher* (pauses)
>
> **Learners:** *the resistor*
>
> **Teacher A***: the less* (pauses again)
>
> **Learners**: *the less current*

Teacher A also encouraged learners to evaluate each other's responses and make additions where necessary instead of giving the class the correct answers as evidenced by the next excerpt.

> **Teacher A**: *Can you start from here* (pointing at the two resistors connected in parallel). *You can start from here, let's see. You add the current for 2 and 3 and then you get the current for this…. Ok. So who can elaborate on that hee? Who can add to that, to what she has said?*

The foregoing excerpts evidence that to a greater extent, Teacher A's communication pattern was largely two-way with teacher affording learners opportunities to engage in conversations with the teacher and other learners. This is important in science learning because this allows learners to verbalise their conceptions, and also practice talking science.

The communication pattern employed by Teacher B in his lessons was mainly one-way, with Teacher B doing most of the talking. Learners were mainly passive listeners during the lessons. There were very few instances where learners were observed engaging in the lesson's conversations. Instances that Teacher B asked questions, he swiftly answered the questions himself without giving his learners a chance to engage with the questions and try to come up with responses to questions asked. The following excerpts below show a few of the numerous instances where Teacher B posed questions and gave answers to these questions himself.

> **Excerpt 1**: *What is speed? (*Teacher does not give the learners an opportunity to answer the question but quickly answered the question himself) *Speed is a scalar quantity*

Excerpt 2: *Vectors have size, magnitude and direction. Scalars are what? Are quantities with size only.*

Excerpt 3*: What is displacement? Displacement is distance in a specified direction or distance travelled in a given direction.*

The utterances by the teacher demonstrate how the teacher stifled the learners' verbalisations during the lesson. By not giving his learners time to respond to his questions, Teacher B tends to deny his learners the opportunity to engage in the lesson's conversations. The learners, therefore, were not able to verbalise their ideas, and also learn how to express their ideas in a scientific manner. The fact that Teacher B did not allow enough time for learners to respond to his questions or the way he responded to what he thought were wrong responses from learners (demonstrated by the excerpt below), or both might have contributed to the learners' lack of enthusiasm to engage in the conversations going on in the lessons.

Teacher B*: What is displacement? What is displacement? What is displacement?*

Learner: *Change in position*

Teacher B: *Change in position? No*

Learner: *Change in position*

Teacher B: *I said no! (Shouting). Displacement is distance in a given or specified direction. Didn't l tell you that? I did. You forget fast…..*

The excerpt above demonstrates that Teacher B did not seem to respond well to learners making mistakes. Shouting out in response to the learner's response could mean that he was angered by what he thought was a wrong answer. In fact, the learner was correct to say that displacement is change in position. The notion he gave that the learners' response was incorrect could act as further cause of confusion in learners and this could result in the unwillingness of learners to participate. The way the teacher responded to the learner's response tend to scare the learners causing them to shy away from attempting to respond to the teacher's questions. This lack of talking about science in the classroom could negatively impacts on internalisation expected to happen through language use.

4.2.3. Explanation and of non-technical and technical words and differentiation of everyday and scientific meanings of non-technical terms.

Both Teacher B and Teacher A made attempts in their lessons to provide meanings of some of the technical and non-technical words or phrases used during the lessons. Some of the words or phrases that Teacher B provided their meanings include *scalar quantity, magnitude*, *vector quantity, velocity* and *displacement.* Instances where Teacher B explained the meanings of some of the words or phrases used are demonstrated by the following extracts from Teacher B's utterances.

Teacher B: *What did we say is a scalar quantity?*

Learners: *Quantity with a magnitude only*

Teacher B; *Yes it has a magnitude. If we say magnitude, it means it has a size.*

In these excerpts immediately above, meanings of both scalar quantity and magnitude were provided.

Teacher B*:* *Vectors have size and direction….. What is a vector quantity?*

Learner: *Any quantity that has magnitude and direction*

Teacher B: *Yes, any quantity that has size and direction….*

The meaning of vector quantity is given in the exchange that occurred between a learner and Teacher B. By repeating the learner's answer, Teacher B seems to accept and also confirm the meaning of 'vector quantity' provided by learner. Teacher B also provide meanings of displacement and average velocity as demonstrated by the following excerpt.

Teacher B. *What is displacement? Displacement is distance in a given direction…*

Teacher B: *What is average velocity? Average velocity is change in displacement over change in time*

Teacher A made several attempts to provide meanings of some of the words that are crucial to understanding of the topic on electric circuits. The words/terms that teacher A provided their

meanings included *series, Ohmic resistor, inversely proportional, directly proportional, controlled variable, independent variable* and *dependent variable*. The following excerpts demonstrate some of the instances when teacher A explained the meanings of terms used in the lessons.

Teacher A: *The higher the voltage, the higher the….* **Teacher A***: But they are in series with other resistors. It can be eeeh two resistors in parallel with maybe one resistor in series with them. Remember series means one after the other…..*

Teacher A*: Right, can we proceed. He said, he said eee, the current passing through the resistor is directly proportional to the voltage across the resistor provided the temperature of the resistor remains constant. Right, in such a case, we say that the resistor is Ohmic resistor. Why Ohmic? Because it obeys Ohm's Law. Right, which resistor is Ohmic? Is the one that obeys Ohm's Law. In other words, we mean to say, eeee, the value of the resistance remains constant. Right. What can change the value of the resistance is the temperature of the resistor……*

Teacher A*: So what relationship between I and R?*

Learner: *Inversely proportional*

Teacher A: *Inversely proportional yeh? So what does that mean? The bigger the* (pointing at I)

Learners: *current*

Teacher A: the smaller the (pointing at R)

Learners: *resistance*

Teacher A: *Do you get that?*

Learners: *Yeah*

Teacher A: *Let's look at those values hey. Eeeeeh, those, that's the table of results hey. Eeeeeh but by just looking at this you can tell us what happens to, to your current just by looking at this. Can you all look at the values and try to….state what happens to current as voltage increases. Thando?* (not learner's real name)

Thando: *The higher the voltage, the higher the current*

Learners*: Current*

Teacher A*: Current also increases, right and then eeeh there are some terms in physics we use*

Learner: *Directly proportional*

The above excerpts show that teacher A explained some of the words/terms used in teaching of science to enhance understanding of these science concepts.

However, I observed that both Teacher B and Teacher A did not provide meanings of some of the important vocabulary words used in their lessons. There are some words/terms that Teacher A did not explain which ought to be explained. These words/items include such words as *resistance, current, voltage, resistor* and *resistors in parallel.* The words *resistor, resistance* and *current* were used numerous times in the lessons, however, the teacher did not provide meanings of these words when used in a science context. These three words are examples of words that are also commonly used in everyday language with different meanings. There is need to explain meanings of such words so that learners are aware of their explicit meanings when presented in a science context (Oyoo, 2012). The word *voltage* was also not explained despite being used several times during the lessons. Technical terms also need to be explained so that learners become aware of their meanings. Since this topic is covered in earlier grades and this was a grade 11 class, it could be possible that the teacher assumed learners already knew the meanings of these words and hence felt no need to explain them.

Teacher B did not provide meanings of words e.g. *fundamental, motion* and *distance*. I also observed instances where in my opinion Teacher B's explanations could have created confusion in learners. Some of those instances are highlighted below

> **Teacher B:** *Ok let us quickly look at force. What is force? People watch this. Watch this chalk. (teacher throws the chalk upwards and catches it on its way down). I pick it up. It is force….*

The example given by the teacher in the excerpt above could have created a misconception about force. Learners may view force as an object which is visible and tangible, instead of viewing force as an invisible push or pull exerted on an object. Teacher B's utterance that "I pick it up. It is force" may lead learners to believe that chalk is force. This illustration in my

opinion was not appropriate to enhance understanding of the concept of 'force'. The extract below shows an attempt by Teacher B to explain meaning of equal vectors.

> **Teacher B:** *Are these vectors are they equal? What do we mean by equal vectors?*
>
> **Learner:** (says something inaudible)
>
> **Teacher B:** *When we talk of equal, we talking about size, we talking about what? Size. They are same, they are equal forces. But their directions are different. They must be equal forces. You know what is called equal? If F1 equal 2N downwards and F2 is equal to 2N upwards, these forces are equal but their directions are different. They are the same forces and same size, equal forces. Equal forces equal vectors, but different directions. These forces are equal but their directions differ. The equal vectors in the sense that their magnitude is the same but their direction is different.*

The above explanation of equal forces and equal vectors is incorrect. Equal vectors, e.g. equal forces, are two or more vectors that have the same magnitude and direction. So, the wrong explanation of equal vectors will result in a misconception of what equal vectors are. The next excerpt also illustrates how Teacher B could have left learners with a confusing meaning of velocity.

> **Teacher B:** *Velocity is a vector quantity because it has magnitude and direction. If you look at your vehicle or taxi, if you look at the speedometer and is moving very fast. It is distance over time*

Teacher B then proceeds to write on the board:

$$Velocity = \frac{displacement}{time} \quad or \quad \frac{change\ in\ displacement}{time}$$

This explanation could have left learners confused about what velocity is. He was not explicit in the excerpt above whether the speedometer shows speed or velocity. In my opinion learners were made to understand that the speedometer of a vehicle shows velocity, which is not correct. However, the fact that he consolidated the meaning of velocity by giving the formula for calculating it could assist learners understand the concept of velocity better.

I also observed that both Teacher A and Teacher B did not make an attempt to distinguish between everyday meanings. Teacher A did not attempt to differentiate between everyday meanings and science contextual meanings of the following words: *series, resistor, resistance, control and current*. Teacher B did not make an attempt to distinguish between the everyday meaning of the word 'speed' from its science contextual meaning. In everyday language, the word speed means moving very fast, while in science it means rate of change of distance only. Instead of just explaining meaning of words when used in the science context (e.g. series and speed), Teacher A and Teacher B could have started by soliciting the learners' pre-instructional understanding of these words since these words also form part of social interactions outside the science classroom. Then both teachers could highlight the similarities (if any) and the differences in the two meanings. That could have helped learners understand the meanings of these words better when presented in the science context. Failure to expose learners to the different meanings of such words may cause learners to have misconceptions since some may still apply the everyday meanings in the science context.

4.2.4. Is the language used simple and easy to understand?

Teacher A used simple language throughout the three lessons. He did not use complicated words that could have made it difficult for the learners to understand what was being taught. The teacher was not reading texts directly from a text book. This is an indication that the teacher seems to have a good content knowledge of the topic and hence was able to present the lesson using his own words that he knew learners would understand better. The fact that he explained some of the words he thought learners needed more assistance with also helped in making the language used simple and easy to understand. This way the teacher ensured that the science concepts being taught were accessible to the learners.

Teacher B also in most instances, presented his lessons in simple language that l believe learners will be able to understand. However, l observed instances when Teacher B provided meanings of some words by simply reading directly from the textbook, as the next excerpt shows:

> **Teacher B*:*** *Let us quickly look at what they have in the textbook. There is what we call a frame of reference. A frame of what? A frame of reference. (teacher then reads the definition from a textbook). A frame of reference is a set of references points which has set of axes that enables position of an object to be defined….. Any object or any quantity that is motion must have a position, must have, have a frame of reference……*

As the excerpt shows, Teacher B read text directly from the textbook as a way of providing the meaning of "frame of reference". Teacher B did not even attempt to further explain the text into simpler language that learners could comprehend better. While it may not always be necessary to breakdown textbook words into simple forms to improve the understanding of a concept, however, in this instance, the language in the textbook may require further explanation, especially considering that these are grade 10 learners who may not have yet a lot of experience in the language of science. The teacher could have assumed that the learners understand what a "set of axes" mean. Sometimes giving learners the textbook definition as is in this particular case could have made this concept too abstract and beyond these learners' comprehension. The teacher could have instead defined "frame of reference" in simple language such as referring to a frame of reference as a 'starting point from which motion of an object is measured'. Use of simple or plain English, referred to as Anglicization by Schoerning (2014) can be used to make learners' understanding of science terms better. Learners would understand 'starting point from which motion of an object is measured' better since this explanation is made up of simple vocabulary that learners are used to than 'a set of axes'.

4.2.5 Other observed practices used by participant teachers that could have impacted on learning of science.

I observed other practices by Teacher A that seemed to facilitate successful learning of science. Teacher A presented all observed lessons in a clear and loud enough voice that could be heard clearly from the back of the classroom. His speed of talking was neither fast nor slow. It was also evident from the way he interacted with the learners that he had a good rapport with his learners. The learners were not timid and did not display any non-verbal behaviour that suggested that their relationship with their teacher was anything but good. Creation of a safe learning environment is conducive to successful learning. This was evidenced by the fact that he allowed some learners to work out some of the questions on the board. Teacher A also conducted a practical activity during which learners were investigating the relationship between voltage and current when resistance is kept constant. This is a good practice that was meant to enhance the understanding of Ohm's law. Learners were also able to ask for the teacher's assistance during the practical. The constant asking of questions by the teacher encouraged engagement of learners in the lesson's conversations in addition to focusing learners' attention and also to confirm that they were following the lesson.

I observed that Teacher B seemed to talk fast during all the three lessons. Fast pace of talking may result in learners not comprehending what is being said by the teacher. It is also very easy to misspeak when one speaks very fast as evidenced by the excerpt below.

Teacher B: *Mass is measured in Newtons…*

Due to his fast way of talking, Teacher B does not seem to realise that he made a mistake and continues talking leaving this mistake unrectified. Indeed slips of the tongue are a common occurrence even when one speaks slowly, but in my opinion slips of the tongue are more rampant in fast speech than in slow speech. Also it is easy to recognise one's slip of the tongue when speaking slowly than when one is speaking fast.

Probably he was anxious to complete this section before commencement of examinations since it is one of the main topics assessed in the grade 10 physical sciences paper 1 final examinations. It could also mean that the teacher lacked good content knowledge of this topic, therefore felt the need to simply rush through it without giving learners to answer or ask questions.

4.3 Analysis and findings from educators' interview

Only Teacher B agreed to a follow-up interview with the researcher. Teacher A pulled out of the interview due to work commitments.

Teachers' interviews were conducted after the lesson observations and verbatim transcriptions of the observed lessons. The purpose of the educators' interview was to find out directly from the educator a number of issues of concerning the science classroom language:

- Is the teacher aware that language can be a barrier in successful learning of science?
- Does the teacher believe that there is a difference between everyday language and science classroom language?
- The teacher's approach to language use in the science classroom

4.3.1 Is the teacher aware that language can be a barrier in successful learning of science?

Teacher B's response to the question by the researcher suggests that he is aware that language can be a barrier to learning science as evidenced by the excerpt below

> **Researcher:** Do you think learners have a problem with language in science?
>
> **Teacher B**: *The science language starts with the science dictionary. Most of our learners find the language in science difficult. They need science dictionaries to explain science terms. 60% of our learners do not have basic science or physics background content. More than 60% do not have basic language in science.*

Teacher B is quite aware that learners do experience challenges with the language used in the science classroom. The percentages he stated of learners in his class that he says do not have basic language in science is proof that most of his learners experience challenges is the

language itself. He agrees that this difficulty becomes evident during learner assessments and this further affirms this problem, as shown in this next excerpt.

> **Teacher B:** *Teaches are not always aware of this except when we evaluate kids when we find that most of the kids have made mistakes one way or the other.*

4.3.2 Does the teacher believe that there is a difference between everyday language and science classroom language?

The interview showed that the teacher's beliefs with regards to difference between everyday language and science classroom language are conflicting. The teacher's initial response to the researcher's question shows that Teacher B believes that there is very little difference between everyday language and science classroom language

> **Researcher**: *Do you think language in science is different from everyday language, for example English in general?*
>
> **Teacher B**: *No, actual there is little difference there, especially in specialised words. They differ a little bit. English language supersedes or controls the science language*

But Teacher B's next response is in direct contradiction with his utterance above.

> **Teacher B:** *The basic language learners do have it, that is, in terms of meanings of words, the basic understanding or meanings of topics. When we talk of specialised language, like terminology is a problem because the English language does not explain much of those terms in terms of science, especially physics. The English language does not explain deeply or vividly the specialised terms in science, especially physical science. For example, the focal point. The English explanation of the focal point can be different from the explanation in science. The word is quite different from English, but you need to explain it in science.*

In a way, this shows that Teacher B is quite aware that there are differences between everyday language and science classroom language. The excerpt shows that Teacher B is conscious of the fact that ordinary English does not fully explain the specialised terms in science. Specialised terms referred to by the teacher could be taken to be technical words which are deliberately used in science with a specific meaning (Oyoo, 2012) which is not common in everyday language. The teacher proceeds to give an example of a term: focal point, whose meaning in

science is different from its everyday meaning. This shows also that the teacher is aware that everyday words presented in science context assume meanings that are completely different from their everyday meaning. Teacher B suggests other science teachers may not be aware of this fact, and posits that teachers (including himself) may not be explaining the meaning of words used in science to learners, as evidenced by his utterance below.

> **Teacher B*:*** *Generally when you are teaching these kids, the mind-set might not always go towards the specialised language, rather than general terms.*

He also expressed his belief that teachers can contribute to the misunderstanding of the words used in the science classrooms when asked by the researcher.

> **Teacher B*:*** *Yah, yes. Teachers can contribute to misunderstanding of terms or words. It depends on the background of the teacher. Teachers can contribute to the success or failure of the children. If somebody is not specialised in the field of study, he or she may not be carrying the required standard of that subject. This is why teachers of different fields are being updated to their areas of specialisation. Teachers can easily contribute to the success or failure of kids.*

The excerpt above shows that the teacher is aware of the importance of a teacher's oral instructional language in learning of science. He knows that it is important that a teacher explains and make explicit the meanings of both technical and non-technical to enhance understanding of science concepts. He is also aware that not paying special attention to specialised terms creates problems that only become evident during assessment of learners.

4.3.3 The teacher's approach to language use in the science classroom

The discussion with the teacher showed that the teacher was aware that language can be a barrier in learning if the teacher is not vigilant with how she/he uses the science classroom language during teaching. The researcher was then interested in finding out his views on what science teachers should do in order to address the language problem in science classrooms.

> **Researcher:** *Since you acknowledge that language in science is a problem, how best do you think that can be addressed on the part of the teacher? What do you think the teachers could do to improve language?*

Teacher B: The language of science?

Researcher: Yes

Teacher B: *It depends. Language of science begins on the first phase of learner school work, eh…eh, for example written as basic foundation. The language of science must be taught from the first time the learner goes to school or the learner enters the classroom. The teacher should try his best to give meanings from textbooks. Actual the textbooks we are looking at here are the dictionary meanings of the specialised words apart from the normal classroom textbooks.*

Teacher B goes on to explain that proficiency in English does not translate into proficiency in science language, and acknowledges the role of the teacher in assisting learners in acquiring science language proficiency.

Teacher B*: For example if a learner speaks or knows English well, it does not mean he is going to do well in science if he does not have the required basic terminology to write the science. So the only way is to make sure that in as much as the learner may understand simple English, and use it to answer questions, you can point out to the learners the importance of using this science language in order to interpret the questions or in order to write accurately otherwise if they use general language to answer questions they may not get maximum marks.*

This utterance by Teacher B strongly suggest that the teacher will likely exercise caution when teaching science to learners by explain meaning of words that are crucial to understanding of science concepts being taught. But the next exchange shows that even when a teacher is aware of the importance of explaining words used in science, sometimes teachers are not very careful with words that they sometimes use in class.

Researcher*: I just picked up something in one of your lessons when you were teaching about acceleration. You used three words when you were describing negative acceleration. You used the words deceleration, retardation, and…..*

Teacher B: *Yes l used three terms. You call it retardation when it is going down or you call it deceleration when the speed is going down. As l said negative acceleration can be called deceleration, retardation or declaration.*

When asked to explain meaning of declaration, Teacher B had this to say.

Teacher B*: Declaration is the opposite of acceleration. But we normal use deceleration in their textbook. But in my textbook which l used back home they also*

call it declaration. You can also check. They are all the same or similar. They are all synonyms. They are anonyms.

This extract also shows that confusion of words that sound similar is a common problem in science (Oyoo, 2012). This confusion also contribute to misunderstanding of science concepts resulting in misconceptions and failure. Probably this teacher inherited this wrong word from his own science teacher and now he is passing it on to his own students.

4.4 Discussion

The findings of the study show that the participant teachers did not provide the meanings of all words crucial in understanding of science concepts by the learners. In my previous study, one of the findings was that learners have difficulty with comprehension of words used in science, especially non-technical words (Oyoo, 2012). The fact that teachers may not be providing meanings of words used in science could be the reason why science students have difficulties with the science language. The teacher is expected to expose learners to meaning of all important vocabulary words not only part of it. The reason why the participant teachers did not provide meanings of all the technical and non-technical words could be that the teachers assumed that learners were already familiar with meanings of these words. This notion that teachers assume learners already know the meaning of words before coming into the science classroom was also confirmed by Teacher B in the educator follow-up interview. However, Teacher A explained more words than Teacher B. Teacher A used simple and straight forward language to explain meanings of some of the words he thought needed their meanings explained. Teacher B on the other hand, despite the fact that he acknowledged the importance of explaining specialised words used in science, did not attempt often to explain meanings in a language that can be accessible to learners. Instead he read definitions directly from the textbook, and even lamented the fact that learners did not have science dictionaries from which they could read definitions or meanings of specialised science words.

Failure to explain the meaning of all important vocabulary means that the teachers were not giving enough guidance and scaffolding, as expected in the constructivist perspective of learning. Scaffolding is necessary to enable acquisition of the correct proficiency in science language necessary for shared understanding between the teacher and learners during science lessons. The constructivist perspective view learning as a socially mediated activity through use of language that allows sharing information between the knowledgeable teacher and his learners. Lack of shared understanding between the teacher and learners may result in the concepts that the teacher is trying to teach to the learners to be neither plausible, fruitful nor intelligible (Posner et al., 1982.) It also indicates that learners may not acquire the necessary language for learners to enter into the science community.

None of the participant used their learners' prior understandings of some non-technical words to build their understanding of meanings of these words when they are presented in a science context. This is in direct contradiction with the constructivist perspective on learning which recognises the importance of learners' prior knowledge in construction of new scientific knowledge. This shows that the participant teachers do not recognise the importance of learners' pre-instructional conceptions to learning of new conceptions.

The lack of engagement of learners in the observed lesson's conversations observed in Teacher B's lessons could also be contributing to poor development of the correct science language in learners. Learners need to engage in talk occurring during the process of teaching and learning science so that they develop their language skills. According to Scott, Mortimer, and Ametller (2011), "the internalisation step does not involve the learner absorbing knowledge fully formed from the interaction of the social plane. …..learning … is regarded as being essentially dialogic process, which involves bringing together and working on ideas" (p. 4). This quote confirms the importance of learners' engagement in everything that occurs in the classroom, including

engaging in the classroom talk as a way of reconstructing for themselves the meanings of words used in science, hence the language of science. The teacher can also be able to identify learners' misconceptions with regards to misuse of words and offer the necessary assistance immediately.

Other factors that were observed that could be indicators of ineffective use of a science teacher's oral instructional language is their speed of talking. This was evident in Teacher B's lessons. He seemed to be rushing through the lessons. By doing this, Teacher B may have missed the chance of engaging his learners in the lesson's discussions and not having enough time to explain the specialised words he is quite aware exists in science. Some of the information was evidently distorted, l believe, due to the fact that the teacher was perhaps concerned with finishing the lesson without paying much attention to what he was saying.

4.5 Chapter summary

In this chapter, the findings from the lesson observations and interview with one of the participant teachers are discussed. Some of the findings from the lesson observations were that in some instances the participant physical sciences teachers did not provide meanings of both technical and non-technical words used, none of the teachers used their learners' prior understanding of non-technical words, and that participant Teacher B did not encourage participation of his learners in the lessons' conversations as much as Teacher A. The face-to-face interview with Teacher B showed that Teacher B is aware that learners experience challenges with science language, and that meaning of non-technical words when presented in a science context is sometimes different from their everyday meaning.

In the next chapter, the conclusion, implications, recommendations and limitations of the study are presented.

Chapter 5: CONCLUSION

5.1. Introduction

In this concluding chapter, l present the summary of the findings of this study, the implications and recommendations, limitations of the study, generalizability of findings of this study, and my reflections.

The raw data for this study was collected by naturalistic observation of physics science lessons presented by two South African high school physical science teachers, and also from follow-up interviews with one of the participant physical science educators. As already outlined, this study was aimed at finding out how South African physical science teachers are using their oral language in the classroom to enhance understanding of science concepts by their science learners. The motivation for the study is the continued poor performance by South African learners in science education in general, and in particular in the matric physical sciences final examinations.

5.2. Summary of the findings

Underlying the issue of language in the South African science classrooms is the fact that the language of instruction, in most cases, is English, a language which is not the home language of either the learners or the teachers themselves. Regardless of this problem, teachers as the knowledgeable others are still expected to assist the learners to understand science concepts being taught in English.

Analysis of the transcripts obtained from the lesson observation videos revealed the following findings. The participant educators made efforts to use oral language to assist their respective learners understand the, more often than not, abstract science concepts.

It was observed that participant science educators made efforts to assist learners in understanding concepts taught by providing the meanings of some of the technical and non-

technical words that formed part of their classroom language. As already detailed in section 4.2.1, the two teachers provided the meanings of some of the words or phrases crucial to the effective understanding of concepts being taught. This showed that the participant teachers might be aware of the importance of providing meanings of words they believed the learners lacked understanding of. Teacher B conceded during the follow-up interviews that language might act as a barrier to learning of science if the language is not used properly. Therefore, Teacher B's effort in providing meanings of words was motivated by this awareness of the possibility of language being a barrier to successful science learning. However, both teachers did not explain the meanings of all the technical and non-technical words they used in their lessons. These words included such words as *resistance, fundamental, motion, distance, current, voltage, resistor,* and *resistor in parallel*. This omission presents a problem in itself in that learners were not exposed to the meanings of all words that are pivotal to understanding the concepts that were being taught. The meanings of the words used in science is foreign to learners (Oyoo, 2012); and learners need to be exposed to these meaning by the teachers who are supposedly 'masters' of science subject matter. So, this failure to explain meanings of technical and non-technical words presented in a science context could be a contributing factor to the poor performance by science learners due to lack of shared meaning between the teacher and learners. Understanding of science, as outlined in the conceptual framework for this study, in Section 2.2, begins understanding of the science language, since science knowledge is inseparable from the words in which that knowledge is codified [Postman & Weingartner (1971) cited in Hodson (2009)]. It is only logical then to conclude that learning of science also begins with understanding of the words and phrases which form part of the science teacher's oral language. In the science classroom, the teacher, as the main source of knowledge, has to use his oral language to transmit knowledge to the learners, and also try to explain texts in textbooks in a manner that is simple and easy to understand. Therefore, it is important that

learners understand all the words that make up the teacher's oral language. This facilitates decoding of science knowledge that is coded in the teacher's oral language.

It was also observed that Teacher A made great efforts to involve his learners in the conversations that were occurring during the lesson. However, in Teacher B's lessons, the communication style used was largely one-way, with Teacher B doing most of the talking. There was a little bit of engagement from learners. In a way, learners in Teacher B's classes were just passive receivers of knowledge who were not given enough chances to actively construct their own meanings by engaging in the classroom talk. Engaging in the ongoing classroom talk helps learners to acquire the correct language as they interact with the teacher. Language is important in learning since it is the light of the mind (Okebukola et al., (2013), and therefore, shapes learners' thoughts. Talking about science is crucial for conceptual development which preludes learning. Engaging learners in lessons conversation will go a long way in assisting learners develop appropriate language skills that will help them to engage meaningfully with science concepts. Learners' talk goes a long way to assist learners to become proficient in both the language and concepts so that they become scientifically literate (Fung & Yip, 2014).

Another finding from the transcripts was that both participant teachers did not differentiate between everyday meanings of non-technical words and the meanings these words assume when presented in a science context. This showed that the participant science educators were oblivious to the assertion that "everyday words when used in a science context cease to be mere English words" (Oyoo, 2008, p. 113). To avoid transportation of everyday meanings of non-technical words into the science context, teachers should highlight the differences between these meanings so that learners realise why some of the everyday meanings would not apply in a science context.

It was also observed that in some instances that participant Teacher B presented to learners definitions of words or phrases by reading from a textbook without any further attempts to simplify such definitions. Sometimes it is important for a teacher to use plain or simple vocabulary words to make learners understand a textbook definition. This is particularly important when words used in the textbook are too abstract and not common in everyday conversations. Use of plain English words sometimes help learners get a better understanding of complex and abstract science concepts (Schoerning, 2014).

Teacher B was observed to be rushing through his lessons. It could be that he was under pressure to complete the work schedule. It could also be that he lacked enough content to tackle the topic thoroughly and could not wait to quickly go through that topic.

In conclusion, all the stated observations culminated in both participant teachers not effectively using their oral classroom instructional language to enhance understanding of science concepts. So the shortcomings of the participant teachers may result in learners not being "appropriately/contextually proficient in the language of the science classroom" (Oyoo, 2008, p. 113).

5.3. Implications and recommendations

The major revelation in this particular study is that the participant South African physical sciences teachers are not effectively using their oral instructional language to enhance understanding of science concepts in physics lessons. This is despite the fact that one of the participant physical science educators is aware that a teacher plays an important role of explaining meanings of words that are used in science. This will not assist learners to acquire proficiency in the language of science, especially considering the fact that the participant learners are second English language users.

In view of the findings, l make the following recommendations. Firstly, physical sciences teachers should be sensitised to the importance of the science teacher's oral instructional language in teaching and learning of science. Teachers should be aware that all of what learners learn in science starts with understanding of words and phrases that form the science language. This could be achieved through hosting of workshops where teachers will be trained in language issues. Currently, science teachers are attending workshops to be trained in content issues only. The stakeholders that are arranging such workshops should also be sensitised to the need of conducting language workshops. It will be a futile exercise to equip teachers with content knowledge that will not be transmitted effectively to learners due to lack of shared understanding between teacher and learners.

I also recommend compilation of a glossary of everyday meanings and science context meaning of common non-technical words used in the science context that can be used by both science teachers and their respective learners. I make this recommendation in view of the fact that cross national studies have revealed that science learners experience difficulties more especially with non-technical words used in science, and the fact that participant teachers in this study did not provide meanings of all the non-technical words that were used during the observed physics lessons. Availability of such glossary might assist teachers realise the importance of explaining meanings of words used in science (technical and non-technical). The utterances by Teacher B during the interview shows that teachers may be assuming that learners already know meanings of non-technical words since they are also commonly used in social interactions outside the science classroom, forgetting the fact these words assume completely different meanings in science.

5.4. Limitations of the study

Factors that could have limited the validity and reliability are as follows. The study was a case study and the sample of South African physical science teachers used in the study was too small. The two teachers that participated in the study might not be enough representation of a large population of South African physical science teachers. Also the number of lessons observed and video recorded was too small to truly reflect what goes on in physics lessons in South African science classrooms. Validity and reliability of study could have been improved by engaging more participant educators in the study, and also by observing and video recording a larger number of lessons from many different teachers.

Another factor is that only one educator participated in the follow up interviews. His views on teacher's classroom language may not be representative of the South African physical science teacher population.

5.5. Generalizability of the findings of this study

Foregoing the limitations of this study discussed above, findings of the study offer important and useful insight of what occurs in the South African science classrooms with regards to how science teachers' use of their oral language might be a contributing factor to the continuous poor performance in physical science by South African science learner. According to Gerring (2004), findings of a single case study may be generalised to a larger class of similar units that have unit homogeneity with the case. Homogeneity allows the case study and the larger class of similar units to be comparable. Punch (2009) also posits that findings of a case study can be generalised through conceptualisation and developing propositions. In view of these justifications, it is possible to apply findings of this particular case study to all other South African physical science teachers. The participant science educators could be used as a fair representation of other South African teachers since there is homogeneity in the two groups.

Most South African science teachers like the participant teachers are practising in science classrooms where the language of instruction is neither that of the teacher nor the learners. They both have a dual challenge of teaching their respective both the science content and the appropriate language necessary to understand those concepts. All South African physical science teachers have to be qualified to teach science, and are teaching science according to a specified national curriculum. The poor performance in science is national and not limited to certain schools or to learners taught by particular teachers. So, it is highly likely that what was observed in these few lessons occurs in most physics lessons. The findings of the lesson observations could also be found if different teachers were involved in the study. The views expressed by Teacher B during the follow up interviews could be shared by many other South African science teachers. Therefore, it is logical to conclude that there could be other South African high school physical science teachers who are not effectively using oral language to enhance understanding of science concepts by learners. Therefore, these teachers' oral language may be a contributing factor to the below expectations performance in science by South African physical science learners.

5.6 Reflections

Conducting this study has made me aware of the importance of my oral language in enhancing understanding of science concepts. This study has once again reminded me of the importance of providing meanings of words (both technical and non-technical) l use during teaching of physical science concepts to my learners, allowing my learners to engage fully in the lesson conversations, and the use of simple vocabulary words for enhanced understanding. While my last study created in me the awareness of learners' difficulty with nontechnical words presented in a science context, this study has left a lasting impression on me, of my important role as a teacher to use my oral language effectively in the science classroom so that my learners acquire the appropriate proficiency in the science language. I always take time to share with my fellow

science educators the pivotal role of language in learning and the need for the teacher to expose learners to meanings of words and phrases used in science as a way of improving learner performance in physical sciences.

Had time and resources permitted, l would have liked to include more teachers in my study to get a more representative picture of what is happening in South African science classroom with regards to how the science teachers are using oral language to enhance learning of science

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Appendix 1

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

For administrative use:
Reference no: D2016 / 193
enquiries: Diane Buntting 011 843 6503

GDE RESEARCH APPROVAL LETTER

Date:	**30 July 2015**
Validity of Research Approval:	**30 July 2015 to 2 October 2015**
Name of Researcher:	**Kurwa G.M.**
Address of Researcher:	**192 Darragh House; Cnr Plein and Wanderers Street; Johannesburg; 2001**
Telephone / Fax Number/s:	**083 374 0669**
Email address:	**memorykurwa@ymail.com**
Research Topic:	**South African Physical Sciences teachers' classroom language for enhanced understanding of Science concepts.**
Number and type of schools:	**TWO Secondary Schools**
District/s/HO	**Johannesburg West**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved. A separate copy of this letter must be presented to the Principal, SGB and the relevant District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted. However participation is VOLUNTARY.

The following conditions apply to GDE research. The researcher has agreed to and may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

CONDITIONS FOR CONDUCTING RESEARCH IN GDE

1. The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter;
2. A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB);

2015/07/31

1

Making education a societal priority

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

3. A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned;
4. The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, SGBs, teachers and learners involved. Participation is voluntary and additional remuneration will not be paid;
5. Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal and/or Director must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage;
6. Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year;
7. Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.
8. It is the researcher's responsibility to obtain written parental and learner consent;
9. The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources;
10. The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations;
11. On successful completion of the study the researcher must supply the Director: Education Research and Knowledge Management with an electronic copy (and a Hard copy if possible) as well as a Research Summary of the completed Research Report;
12. The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned; and
13. Should the researcher have been involved with research at a school and/or a district office level, the Director and school concerned must also be supplied with the Research Summary of the study.

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

.....

Dr David Makhado

Director: Education Research and Knowledge Management

DATE: 2015/07/31

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

Appendix 2

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 Private Bag 3, Wits 2050, South Africa. Tel: +27 11 717-3064 Fax: +27 11 717-3100 E-mail: enquiries@educ.wits.ac.za Website: www.wits.ac.za

11 November 2015

Student Number: 691428

Protocol Number: 2015ECE055M

Dear Govero Memory Kurwa

Application for Ethics Clearance: Master of Science

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate, has considered your application for ethics clearance for your proposal entitled:

South African physical sciences teachers' classroom language for enhanced understanding of science concepts

The committee recently met and I am pleased to inform you that **clearance was granted**.

Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely,

MMaseko

Wits School of Education

011 717-3416

cc Supervisor – Dr Samuel Oyoo

Appendix 3

LETTER TO THE PRINCIPAL

DATE: 21-06-2015

Dear Sir/Madam

My name is Govero Memory Kurwa. I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on**: *South African physical sciences teachers' classroom language for enhanced understanding of science concepts***

My research involves observing FET physical science lessons and audio/video record the lessons. The audio/video tapes will then be transcribed verbatim and analyzed to answer research questions. A total of three lessons (preferably physics lessons) will be observed within three weeks and videotaped. Videotaping is necessary to minimize disturbance of the lessons, and also provides video data that l can observe several times to facilitate in-depth analysis of the lesson observations

The reason why I have chosen your school is because the language of learning and teaching in your school is English. Your student population consists of learners from different ethnicities and most of these learners are learning science in English which is not their first language. Learning science in a language that is not one's first language is reportedly a challenge to many learners. I am interested in finding out how teachers in your school are using their classroom language to enhance understanding of science concepts by their science learners.

I am inviting your school to participate in this research voluntarily and the school will not be advantaged or disadvantaged in anyway. You are also free to withdraw your school from participating in the study at any time. The research participants will not be advantaged or disadvantaged in any way. They will be reassured that they can withdraw their permission at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The participants will not be paid for this study.

The names of the research participants and identity of the school will be kept confidential at all times and in all academic writing about the study. However some or all of the data collected may be used in conference proceedings or published articles, but note that your school information will not be used to maintain confidentiality and anonymity. Therefore your school privacy will be maintained in all published and written data resulting from the study.

All collected information will be stored safely at Wits School of Education and destroyed after 3-5 years after I have completed my project.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

Govero Memory Kurwa

192 Darragh House, cnr Plein & Wanderers Streets, Johannesburg

memorykurwa@ymail.com. Cell no. 0833740669

Appendix 4

INFORMATION SHEET TEACHERS

23-06-2015

Dear Sir/ Madam

My name is Govero Memory Kurwa and I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on**: *South African physical sciences teachers' classroom language for enhanced understanding of science concepts***

My research involves observing and videotaping physical science lessons. The lesson videotapes will be analyzed to answer the research questions relating to the study. I wish to observe and videotape three of your physical science lessons on physics topics at times that are convenient to you. The reason why I have chosen your school is that most of your learners are learning science in English which is not their home language and these learners may be facing a challenge with learning in a second language. I was wondering whether you would mind if I come and observe and videotape some of your physics lessons so that I find out how you as a science teacher are using your oral instructional language to enhance understanding of science concepts. Videotaping is necessary to minimize disturbance of the lessons, and also provides video data that l can observe several times to facilitate in-depth analysis of the lesson observations.

Your name and identity will be kept confidential at all times and in all academic writing about the study. However some or all of the data collected may be used in conference proceedings or published articles, but note that your personal information will not be used to maintain confidentiality and anonymity. Also, all collected information will be stored safely at Wits School of Education and destroyed after 3-5 years after I have completed my project. Therefore your individual privacy will be maintained in all published and written data resulting from the study.

You will not be advantaged or disadvantaged in any way. Your participation is voluntary, so you can withdraw your permission at any time during this project without any penalty. There are no foreseeable risks in participating and you will not be paid for this study.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

Govero Memory Kurwa

192 Darragh House, cnr Plein & Wanderers Streets, Johannesburg

memorykurwa@ymail.com

Cell no. 0833740669

Appendix 5

Teacher's Consent Form

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called:

I, _____ give my consent for the following:

Circle one

Permission to observe you in class

I agree to be observed in class.
YES/NO

Permission to be videotaped

I agree to be videotaped in class.
YES/NO

I know that the videotapes will be used for this project only.
YES/NO

Informed Consent

I understand that:

- my name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped, photographed and/or videotape

- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____ Date_____

Appendix 6

INFORMATION SHEET LEARNERS

DATE: 23-06-2015

Dear Learner

My name is Govero Memory Kurwa and I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on: ***South African physical sciences teachers' classroom language for enhanced understanding of science concepts***

My investigation involves observation of one of your physical science lessons. The lesson will be videotaped for analysis to find answers to my research questions. You will not be required to do anything outside being present for your science lessons as you normally do

I was wondering whether you would mind if I come and sit in your classroom to observe one of your physical science lessons. I need your help with your participation during the lesson observation and videotaping of the lesson. Videotaping is necessary to minimize disturbance of the lessons, and also provides video data that l can observe several times to facilitate in-depth analysis of the lesson observations.

Participation in this study is completely voluntary and note that you will not be disadvantaged in anyway if you choose not to participate in this study. If however, you choose to participate please note that you are free to withdraw from the study at any time. You may also choose not to be videotaped and this will not have any negative impact on your academic performance.

I will not be using your own name but I will make one up so no one can identify you. All information about you will be kept confidential in all my writing about the study. However some or all of the data collected may be used in conference proceedings or published articles, but note that your personal information will not be used to maintain confidentiality and anonymity. Therefore your individual privacy will be maintained in all published and written data resulting from the study. Also, all collected information will be stored safely at Wits School of Education and destroyed after 3-5 years after I have completed my project.

Your parents have also been given an information sheet and consent form, but at the end of the day it is your decision to join us in the study.

I look forward to working with you!

Please feel free to contact me if you have any questions.

Thank you

Govero Memory Kurwa

192 Darragh House, cnr Plein & Wanderers Streets, Johannesburg

memorykurwa@ymail.com

Cell no. 0833740669

Appendix 7

Learner Consent Form

Please fill in the reply slip below if you agree to participate in my study called:

My name is: _____

Circle one

Permission to observe you in class

I agree to be observed in class.
YES/NO

Permission to be videotaped

I agree to be videotaped in class.
YES/NO

I know that the videotapes will be used for this project only.
YES/NO

Informed Consent

I understand that:

- my name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped, photographed and/or videotape

- all the data collected during this study will be destroyed within 3-5 years after completion of the project.

Sign_____ Date_____

Appendix 8

INFORMATION SHEET PARENTS

DATE: 23-06-2015

Dear Parent

My name is Govero Memory Kurwa and I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on: ***South African physical sciences teachers' classroom language for enhanced understanding of science concepts***

My research involves observing physical science lessons to find out how science teachers are using their language to enhance understanding of science concepts. I will videotape the lessons and also make field notes that will be analyzed after the lessons. Only one of your child's physical science lessons will be observed and videotaped.

The reason why I have chosen your child's class is because it is one of the classes taught by one of my participant science educator. I was wondering whether you would mind if I go and sit during one of your child's physical science lessons to observe and videotape the lesson. Videotaping is necessary to minimize disturbance of the lessons, and also provides video data that l can observe several times to facilitate in-depth analysis of the lesson observations.

Your child will not be advantaged or disadvantaged in any way. S/he will be reassured that s/he can withdraw her/his permission at any time during this project without any penalty. There are no foreseeable risks in participating and your child will not be paid for this study.

Your child's name and identity will be kept confidential at all times and in all academic writing about the study. However some or all of the data collected may be used in conference proceedings or published articles, but note that your child's personal information will not be used to maintain confidentiality and anonymity. Therefore your child's individual privacy will be maintained in all published and written data resulting from the study. Also, all collected information will be stored safely at Wits School of Education and destroyed after 3-5 years after I have completed my project.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

Govero Memory Kurwa

192 Darragh House, cnr Plein & Wanderers Streets, Johannesburg

memorykurwa@ymail.com

Cell no. 0833740669

Appendix 9

Parent's Consent

Please fill in and return the reply slip below indicating your willingness to allow your child to participate in the research project called:

I, _____ the parent of _____

Circle one

Permission to observe my child in class

I agree that my child may be observed in class.
YES/NO

Permission to be videotaped

I agree my child may be videotaped in class.
YES/NO

I know that the videotapes will be used for this project only.
YES/NO

Informed Consent

I understand that:

- my child's name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- he/she does not have to answer every question and can withdraw from the study at any time.
- he/she can ask not to be audiotaped, photographed and/or videotape
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____ Date_____

Appendix 10

Lesson observation transcripts for Teacher A

Transcriptions

Video 20150825-10085

Nd: Morning

L: Morning Mr ND

Nd: Right we are continuing from where we left. But to (inaudible) to start off. We just want to remind ourselves. There are four points that l gave you which l said we should always refer to. Ye. Can you just mention those for me because we are still applying those points? We did this. Which are those 4 points about the resistors in series and resistors in parallel? Yeah Nontokozo

Nontokozo: gives answer but is inaudible

Nd: (repeats learner's answer) Resistors in series are potential dividers.. yes its very important to understand that. Ey ey last year in grade 10 we did an experiment to prove that. What is the other point about resistors in series before we go on to resistors in parallel? We say resistors in series are potential dividers. What is the other point? Yes

L2: the current .... (inaudible)

Nd: the current is the same hey. Right. Lets go to resistors in parallel. Eeee Tryon

L3. Talks inaudibly

Nd: Resistors in parallel are (stops)

Learners chorusing: current dividers

Nd:are current dividers ye? .... resistors in parallel are current dividers. Yesterday we did a question eee where we applied that hee. And then eee second point ee about resistors in parallel? Could we have the answer from that side.

L4:

Nd: ... the d in resistors in parallel is the same. Right which means if you put a voltmeter across each of the resistors ee it must give you the same value. Right today we want to refer to division of current by resistors. But now we still maintain the same type of circuit whereby in the circuit we have got resistors in parallel which are in series with other resistors. I am going to use the same question that we used yesterday but today we are looking at .....(inaudible) right by resistors. So in this circuit we said the current, the main current is 2.5. if you refer to you books you will see that the current that we said is flowing through resistor 1 is 2.5A. And these resistors we say they are equal as you can see the value there. Now can you give me the current through there, the current passing through resistor 2. If l say I2, what is the value of that resist, current passing through this? Guys we did this question yesterday. We were doing the same question yesterday. Right now we want us to, without opening the books. Lets look at this. We are saying this is the current passing through this resistor. Right, now we have got resistor 2 and resistor 3. They are both 1amp and 1 amp right? I want you to give me the current that is passing through this resistor without calculating just. Hands up. Yebo

L5: 1.25

Nd: 1.25 yah. Right. Why this 1.25?

Learners chorus in undertones

Nd; lets speak up guys. Let's not be shy. It doesn't matter whether you make a mistake. Remember l always say eee we learn by making mistakes.

Learners: eeeh

Nd: Yes. So .. (inaudible). Eyeee

L6: Resistors connected in parallel are current dividers

Nd: Resistors connected in, resistors connected in parallel are current dividers. So this main current which comes here is divided , right into two parts, right. The other current passes through resistor 1, resistor 2, the other one passes through resistor 3. But now he says here we get 1.25amps. what are we going to get here?

L; 1.25

Nd: right are you saying its gonna be 1.25amps. Right. Why are they equally?

L: speak inaudibly at the same time

Nd; Because?

L: Resistors in parallel are current dividers.....

Nd; they are current but do they always divide current into equal values?

(interlude of learners whispering or suggesting reason why)

Nd: Lets have our hands up. Lets have our hands pliz. Lets have our hands up to ask questions.

Nd: What l am saying is. We are saying here it's 1.25amps. Can you look at this and here again it's 1.25amps. These values are the same. Do we mean to say that resistors connected in parallel always divide the current into equal values?

Learners: No

Nd: No. So why are they the same here Mondliwa?

L7: Because the resistors are equally

Nd: Because the resistors are equally. So equal resistors will divide the current equally. But if they are not equally they will not divide the current equally. You must know that yeah. Right let me just add here or let me just ask guys. We are saying if the resistors are equally they are going to divide the current equally yeeh? If they are not of the same..... they are not going to divide the current equally. Which, lets say there is a bigger resistor and a smaller resistor, which of the two do you think will have higher current?

Learners speak at the same but one boy says clearly "the one with the bigger resistance".

Nd: The one with a bigger resistor, resistance will have a higher current?

Learners: Yes

Nd: okay

Learner: No sir

Nd: Yee

Learner: Opposite

Nd;You are saying opposite, so which is which now

Learners laugh

Nd: Yee

Learner: the higher the size the less current

Nd: The higher

Learner: the resistor

Nd:Yeah, the less

Nd: the less current

Learner: the less current

Other learners: No

Nd: Which, which law can you, can you use to support that

Learner: Ohm's Law

Nd: Ohm's Law?

Nd: Look, we have talked about Ohm's law haa. Remember this triangle. V, I, do you agree?

Learners: Yes

Nd: Right and then we are saying..... We are saying here ohhh eee. We are saying current yeee

Learner: Yes

Nd: Right. What is the formula there? V over R

Learners: Ya V over R

Nd: So what relationship between I and R?

Learners: Inversely proportional

Nd: Inversely proportional yeh. So what does that mean? The bigger the..(pointing at I)

Learners: current

Nd: the smaller the..(pointing at R)

Learners: resistance

Nd: Do you get that?

Learners: yeah

Nd: Right. Thats what we should know. So this law will always..... Right now lets proceed and see eee. I want to see guys if you give me the current passing through this resistor, R4.

Learner: 2.5

Nd: 2.5amps again?

Learners: Yes

Nd: Why?

Nd: eyy Mxolisi, can you explain that to me

Learner: tries to explain why but is inaudible.

Nd: can you start from here (pointing at the two resistors connected in parallel). You can start from here let's see.You add the current for 2 and 3 and then you get the current for this.... OK. So who can elaborate on that yee? Who can add to that, to what she has said?

Nd: Ehe

Learner: if you .... in that part

Nd: Ehe. In this part

Learner: It will go back

Nd: it will go back and then join yee. So that's why we are adding. So now here we are going to have 2.5amps. right this current is .... can you see that this current is the same . can't they divide, join again. Now you task now is to calculate the potential difference across that, that, that and that in your groups.

(learners then work in pairs to solve the given problem, while the teacher moves around giving assistance)

After sometime one learner goes to the board and writes answer to question.

Nd:Right you must be specific. Which V are we talking about?

Learners: V1

Nd: V1. And again in your formula you must be specific about the current. Right, do you see that guys? When you are referring to resistor 1, talk about current passing through resistor 1, talk about current eee voltage across resistor ee 1 and also that resistor. So the Ohm's law must be, is applicable for each resistor. Current , voltage and resistance must all ,all refer to the same resistor. You can not use the current that passes through another resistor to calculate maybe the voltage in another resistor. It doesn't apply. So some are making a mistake by doing that. They have taken the main current for resistor in parallel which is not the main current and use it to calculate the potential difference there. Let's do the correct thing. So..

(followed by silence, while the learner continues to write the rest of the answers to questions)

Nd; Right, let's analyse this together. Hmm are we happy here?

Learners: Hebo

Nd: Haaa? There is a no and a yes

Some Learners say yes and others say no

Nd : Anathi you are saying no. What's the problem?

(a lot of mumbling from learners)

Nd: Can we have order please. Let's have order so that we can proceed. Right guys eee we are looking Ohm's law. I said Ohm's law is very important. We always apply it eee in circuits. Right look. Will you pay attention Anele. Right, we are saying here, the potential difference of, the voltage across a resistor. We are saying if we connect a voltmeter here. What will it measure? Then we can use Ohm's law to calculate that if we have got current and resistance ye. So in this case it was easy because all these two were given there, right? Ehh, and l was saying to duduzile be specific if you are talking about V1 refer to current passing through resistor 1 and resistance. Then we substituted and got 5ohms, 5volts. So there is 5volts there that is measured by that voltmeter. Right. Here l connect another voltmeter here, and another voltmeter there , right. This one will measure eeeh, 1.25 times 1. Those are the values of current and resistance. So you will get 1.25volts. this one will also measure eeeh, 1.25 by 1. That 1.25 is the one that passes through there, that's the current passing through resistor 3, and then the resistance of that resistor is 1, you that volts. Right, and you said at the beginning that voltage across resistors in parallel is the same. You see that is the same, heee. Right, and then if l do this, let's say l take a long wire and put it here, do you see that l will be measuring the voltage of that resistor. If l throw this wire this side, do you see that l will be having the same thing. I am taking this wire there, right, suppose this is my, my voltmeter hee, l am putting it there. I am connecting it there, do you see that wire goes there, right. And then l can put it here. It's the same hee? If l let it go down, it's the same. So l can use one wire to measure the voltage for both by putting the voltmeter, connecting the wires, by connecting the wires of the voltmeter here. I can measure for both. That's why we don't have to repeat this when we are adding. Do you get the point?

Learners: Yes

Nd: Yes. Just to put here is just to eee move my wire that side but putting them here wil measure that and that at the same time. You don't have to repeat this when you are eeee checking whether the eee these resistors are dividing the voltage.

Video 20150828- 092334 Transcription

Nd: We continue with the topic eee electricity yeh. Morning ee, l decided that before we continue with power can we just do an experiment to verify ohm's law. We will go back to power, right. This is ee the circuit diagram for the, for the. Can you all pay attention. Quiet. Bonani. Right whenever we are doing an experiment, there are three variables. Right can you just mention those variables?

(learners talk at the same time)

Nd: Right let's have our hands up..... Hebo

Learner: Independant

Nd: independent variable. What else?

Learner: Dependant variable

Nd: Dependant variable. Katlego?

Learner: Controlled

Nd: controlled variable. Those are the three variables. Those are the three variables eee you must consider. Right in this experiment remember the ohm's law. You know what it says hee.

Can you just repeat that law again so that we identify those three variables that we have mentioned. Who can state ohm's law in words? (silence) can l have one of you stating ohm's law in words? Eeee . let's have one of you stating ohm's law in words. Remember l said those laws are there in your formula sheet. Just, what you are supposed to do is just say them in words. Say that formula in, in words. You have the formula, you know the formula. So if you cannot remember the law in words, just write down that formula and then try to say it in words. Aaah Anani.

Learner: sir the current passing through a resistor is proportional to voltage across a resistor provided the temperature remains constant

Nd: provided the temperature remains constant yeh?

Nd: Right, can we proceed. He said , he said eee, the current passing through the resistor is directly proportional to the voltage across the resistor provided the temperature of the resistor remains constant. Right in such a case, we say that resistor is ohmic resistor. Why ohmic? Because it obeys ohm's law. Right, which resistor is ohmic? Is the one that obeys ohm's law. In other words we mean to say, eeeh, the value of the resistance remains constant. Right. What can change the value of the resistance is the temperature of the resistor. So if the temperature of the resistor increases i resistance of the substance of the resistor also increases. But in this case when we are talking about ohmic resistor, we mean the resistance remains constant. Which means is not affected by the change. That's why we put that statement to say provided the temperature of the resistor remains what, constant. Which means the resistance won't be affected by eeeh, the resistance of the circuit remains constant. Right, now eeh let's ..... to that law down and then we underline the variables. And then after that we can state which one is independent, which one is dependant and so on in your experiment. Right, so we are saying current passing through the resistor is directly proportional to the potential difference or voltage across the resistor provided the temperature of the resistor remains constant. Now can you give me the variables there so that l underline them from there we give them names. The variables in this law. (silence)

Nd: Khutatso, which are the variables there?

Learner: Current

Nd: Current right. What else? Yes Lindokuhle

Learner: Temperature

Nd: Temperature. Okay. What else? Yes

Learner: Voltage

Nd: The voltage. Those are the three variables yeh? Right. Now which one do you think is independent here?

Learner: Voltage

Nd: The voltage is independent yeeh? So independent variable you is voltage, yeh? Then eeeh this is the one that we fix yeh? So the dependant will be what?

Learner: Current

Nd: Current. Right. Dependant will be what? Current. So you fix what? The voltage then the current will depend on your, on the voltage that you fix yeh. And then the control is what?

Learners: Temperature

Nd: Control is temperature. By control we mean it doesn't change yeh? Control is temperature. It doesn't change. Right now we gave our three variables now. So the circuit diagram is there on the board, right. We are saying here from the positive you connect what, to the ammeter. From the ammeter , first of all you are connecting the main circuit. You are saying from positive to the ammeter, from the ammeter to the rresistor. I will put a bulb because l don't have a suitable resistors here. But a bulb is not ohmic resistor because the temperature will increase. So everytime you take a reading you switch off to avoid what, increase in temperature. So that you are controlling what your temperature there on the resistor. Your resistor is the bulb. So control that eeeh temperature by eeeeh connecting it the bulb for a short time, disconnecting it then after taking the reading. When you are ready to take a second reading, you connect again, take the reading disconnect yeh, to avoid the increase in temperature otherwise it won't come out. So after connecting the bulb there, you go you take a a wire and then you connect it to the cell. Right and then remember eeeh the voltmeter is always connected across the, the resistor. Right the ammeter is always in series because ammeter is just counting how many charges are passing it, eeeh that point per second . (recording stopped for a short interlude)

Nd: We have to connect in series with the..

Learner: resistor

Nd: then this one is across the resistor according to what Anani said. That's why we are connecting the voltmeter across the
Learners: Resistor

Nd: The resistor . you see we are connecting according to ohm's law. Now can we make eeeh three groups. Let's make three groups. We do this circuit. You must have your table of values designed. Remember we said you have got the dependant and independent, the controlled doesn't change you don't have to include here. Maybe you can do that, put room temperature at least room temperature .... so let's have one group here , another one at the back there, another one there.

(learners proceed to carry out experiment in three groups as directed. Teacher moves around the groups checking and giving assistance)

(After the experiment, a class discussion)

Nd: Let have a table from one of the groups. (learner hands a paper with a table of results)

(teacher draws a table of results on the board, proceeds to fill in the results as given by one of the learners)

Nd: Let's look at those values hey. Eeeh, those, that's the table of results hey. Eeeeh but by just looking at this you can tell us what happens to, to your current just by looking at this. Can you all look at the values and try to....state what is happening to current as voltage increase. Thobekhile

Learner: The higher the voltage, the higher the current

Nd: The higher the voltage, the higher the

Learner: Current

Nd: So you mean to say? In another words, who can say that in another, another words?

Learner: (says something but is not audible)

Nd: Current also increases, right and then eeh there are some terms in physics that we use

Learner: Directly proportional

Nd: Directly proportional. Which is directly proportional to the other?

Learner: Voltage is directly proportional to current.

Nd: Yes, ya and then for all this l saw in other table they putting same temperature, same temperature, same temperature yeh. But the temperature we are using is room temperature yeh

Learners: Yes

Nd: We are saying we are using the temperature of the wire at room temperature. That's why we were disconnecting to avoid increase in temperature of the resistor. Otherwise we wouldn't be , we wouldn't be talking about ohm's law. Right, eeee, interpretation of the results, you draw your graph of voltage against what current hey?

Learners: yeeh

Nd: And then you can calculate your resistance . remember resistance , resistance using a graph is the gradient of the graph yeh. The resistance is the gradient of the graph. So now eeeh, can we in our groups just write a short report of what we did starting from the aim until you go to the conclusion. Eeeh, if you can put that at the back of your book, because l want to continue with power on this side. So that's the end of the lesson. Thank you.

Video

Nd: Eeeh, let's pay attention. Ok , r..., l think l mentioned that eeeh that Mam Kurwa will come and observe our, our lesson. She chose three lessons eeh and there is another guy who is going to come and observe us again in energy and change yeh. So make me pass. Right eeh , eeh, the topic is electricity as you know, and today we are just covering parallel resistors in series with other resistors yeh? In this case l mean to say these are parallel resistors yeh?

Learners: Yes

Nd: But there are series with other resistors it can be eeh two resistors in parallel with maybe one resistor in series them. Remember series means one after the other. So these are in parallel but they are in series with this one and that one, right. And our questions here say calculate the current follow, flowing eeh through the cell. Right that current flowing through the cell is the main current or the total current. Right, this is the total current. And remember we said when we are calculating the total current what do we use? Which law do we use to calculate the current?

Learners: Ohm's law

Nd: Ohm's law in that case yeh? Right we are given eeh, eeh the voltage there but now which resistor or resistance do we use there? (silence) Remember we are calculating the total current. Current that passes, passes through the cell is the total current yeh?

Learners: Yeah

Nd: Right.And ohm's law, who can give us ohm's law? Yes?

Learner says the answer while the teaher repeats the answer as he writes it on the board

Nd: The. Can you speak louder than that.

Learner: the current is v times R.

Nd: Right, where v equals the potential difference across th cell. Right, in this case for the total eeh, eeh, the total eeh current we are going to use the total voltage which is the total voltage across the cell yeh?

Learners: Yes

Nd: And then this is the total current that we are going to use. And In this case this resistance l want you to tell me which resistance are we going to use there. (silence)

Nd: Right, if l can write this, maybe l can put it this way (writes on the board), is equals to I multiplied by what (silence). Its now better. So what resistance are we going to use there?

Learner: Total

Nd: Total. So how do you find the total resistance, resistance there?

Learner says something inaudible

Nd: First what?

Learner: (inaudible)

Nd: Okay, l find the effective resistance of these resistors in parallel, then from there what do l do?

Learner: (inaudible)

Nd: I add the parallel eeh, ok with the, that resistance and that resistance right. Then l have my total resistance in the circuit. This is the one that l am going to use there yeh to find the total current yeh. And then this voltage or potential difference willmbe the potential difference there across what? The cell yeh? Right, so let's do that. Who can do that for us? Put your data and then work the problem and then we will discuss together.

(learners work out the problem with assistance from the teacher, then one learner goes to the board to write her working of the solution on the board)

Learner: Should l write the data?

Nd: Ya

(learner proceeds to write the problem on the board)

Nd: Now from there data is there we do we go? Because we don't have eeh the total eeh, eeh resistance, so the first is to solve what? The resistors in parallel hee? Right, and then from there we add all as we have said to find the total resistance before we use ohm's law. So let's do that

(learner proceeds to work out the solution on the board)

Nd: All right from there eeh anything, any comments there? No comment everything is correct?

Learners: Yes

Nd: Right but aaah, l have got two things to mention on, for example here, what is missing in this data? .... Look at the data. Let's say, look at this. What is missing there?

Learners: Chorus something inaudible

Nd: What?

Learner: t

Nd: t?

Learner: (inaudible)

Nd: Ok. The what? T?

Learner: Symbol

Nd: Symbol for what?

Learner: Voltage

Nd: Voltage? Symbol for voltage is there.

Learner: v

Nd: Which v?

Learner: small v

Nd: Hayi hayi guys hey. There is something missing. Let's go to this one. What is missing in this one?

Learners: Ohms

Nd: Ohms, the units hee?

Learners: Yes

Nd: Every physical quantity in physics must have the units. Right, right, ok, ok

Learner: says something inaudible, the whole class laughs

Nd: Right, right. Let's continue, now did you understand this part? (silence) That's why l was asking ukuthi do you have any comment guys, eeh, eeh. Do you have any comment? That's why l was asking that. You must show all the working following the formula that is written there. This might be true, but eeh, you must show it there how you arrive to this part. Right, who can tell us what to do here if you follow the formula? There are two numbers here, right? Let's do this hey? What do l do here? What is the eeh, resistance eeh, R2?

Learners: 1

Nd: You must show it. 1 divided by what?

Learners: 1

Nd: By 1 hey? And this one by

Learners: 1

Nd: This one is 1 over (writes 1). Understand? Right, common denominator there is what?

Learners: It's 1

Nd: It's one hey? Right, and then 1 into 1 is 1 times 1 plus 1 is 1 over R parallel hey? Then which means, eeh, 1 over R parallel is equal to 2 over 1. If you invert this hey? Right eeh, we have 1 over, R parallel is equal to 1 over 2, which is equal to zero point

Learners: 5

Nd: Ohms. So she was correct. Right, now thi is only this part. She has solved this part such that the circuit remains like this(draws a circuit diagram with three resistors in series). You see this is our new circuit after finding this R parallel which is equal to 0.5ohms. this one remains 1.5 we haven't touched it, and this one is

Learners: 2

Nd: Is 2 ohms. Then from there, from there what do we do? Remember we want to find the total resistance hey? So what do we do there?

Learner: (says something inaudible)

Nd: R t, speak up

Learner: R1

Nd: R 1

Learners: plus R 4

Nd: plus R 4

Learner: Rp

Nd: Plus

Learners: R 3

Nd: Yes, and then what do we get there? Is 2 ohms plus 0.5 ohms plus Learners: 1.5

Nd: 1.5 ohms. Then our total resistance will be what?

Learners: 4

Nd: 4 ohms, hey?

Learners: mmh

Nd: Right,now the question wanted us to calculate, eeh, total current. Can you close that door please? Total current which is It is equal to I, where now Vt is equal to I(then writes R on board so that it reads VT = ITR). Then what is our total voltage

Learners: 10

Nd: Right is equal to I we don't know this one multiplied by 4. That's our, our total resistance, hey?

(proceeds to calculate the main current flowing through the battery/circuit and gets 2.5 A)

Appendix 11

Lesson observation transcripts for Teacher B

Lesson 1

NB: words in italics are direct words from the teacher

What is speed? ..... Speed is a scalar quantity (teacher does not allow time for learners to respond).

What is a scalar quantity? Speed is a scalar what? Speed is a scalar quantity.

What did we say is a scalar quantity?

Learners: quantity with a magnitude only (response inaudible*)*

Yes it has a magnitude. If we say magnitude, it means it has a size.

So speed is a scalar quantity because it has size. That is what a scalar quantity is. Velocity ……. Is it a scalar quantity? What is velocity?

Learners: vector quantity (learners responds)

Velocity is a vector quantity. Both speed and velocity are quantities. One is vector quantity while the other is scalar quantity.

Speed = $\frac{Distance}{Time}$ (Teacher writes the formula on the board). The teacher comments that it is important.

Speed is measured in metres per second or kilometres per hour. The SI unit –, remember I said SI unit stands for Standard Internationale Unit. The SI unit for speed is what? It is metres per second. Remember I said speed is a scalar quantity because it has magnitude only. Velocity is a vector quantity because it has magnitude and direction. If you look at your vehicle or taxi, if look at the speedometer and is moving very fast. It is distance over time.

Let us quickly look at displacement. Sorry let us look at velocity. What is a velocity?

The teacher writes the following on the board:

Velocity = $\frac{Displacement}{Time}$ or $\frac{Change\ in\ displacement}{Time}$

Let us quickly look at displacement

What is displacement? (Teacher asks the question three times*)*

Learner: Change in position

Change in position, No (teacher responds to the learner).

Learner: Change in position

I said no!

What is change in displacement? What is displacement?

Displacement is distance in a given or specified direction. Didn't I tell you that? I did. You forget fast. When I say I travel 20km east, the direction is eastwards and that is displacement. And when I say I travelled 20km, this is distance. Mr ….. is driving very fast. What is the speed? 2okm per hour. We are talking about what, speed. But if Mr ……. is driving at 20km per to Joburg, we are now talking about velocity.

Velocity is measured in metres per second just like speed, but must specify the direction. When we mention direction, we are talking about what? Velocity not speed.

Let us go straight to average speed. When we say average speed, when put speed average, Average speed, what do we mean by average speed? Change in distance over time taken

Teacher writes the following formula on the board?

Average speed = $(x_f - x_i)/ (t_f - t_i)$

Let us quickly look at average velocity before we solve some questions. What is average velocity? Average velocity is change in displacement over change in time.

Velocity = $\frac{Change\ in\ displacement}{Time}$ **(formula written on the board)**

People I want you to underline in your textbook the word average speed.

NB: the average speed is written as follows in the textbook:

Average speed = $\frac{Total\ distance\ travelled}{Total\ time}$

<u>Lesson 2</u>

Vector and scalar quantity

Vectors have size (magnitude) and direction. Scalars are what? Are quantities with size only. What is the other word for size? Teacher continues without allowing learners to respond to the question but writes on the board to illustrate the difference.

Let us look at examples of scalar quantities. What do you understand by scalar quantities? What are examples of vector quantities from you own perspectives? … What is a vector quantity?

Learner responds: Any quantity that has size and direction

Yes, any quantity that has size and direction. People let us quickly look at examples. The first one is displacement. The next one which we are going to look at is called velocity. The other one is weight, and the next one is what? It is force.

Let us now look at examples of scalars. One example is time. Time is an example of scalar. What else is an example of scalar?

Learner : mass

Yes mass. Mass is a scalar quantity. What else is an example of a scalar quantity? Mass measures the size.

Charge (Learners respond as a class)

Yes charge…… yes thank you charge is an example of a scalar. The other one is distance.There is what we call fundamental units. Unit of measurement. This is important because every quantity must be measured. Remember what I said? I said quantities are measurable. They what, they measurable.

What is displacement? Displacement is distance in a specified direction or distance travelled in a given direction.

Teacher writes the formula on the board as follows:

Displacement = $\frac{dist.travelled\ in\ a\ given\ direction}{time}$

NB: teacher realises that he has the wrong formula for distance and quickly erases the word time.

*The unit of measurement is metres. There is no time attached to it, it's metres (*Teacher erases the word time from the formula he wrote for displacement). *Let's say for example metres east. For example when I say 30km east, that is displacement. But when I say 30km, that is distance. Let's us quickly look at velocity. Velocity is now change in displacement over time ……. Over what, over time.*

Teacher writes the formula for velocity as follows:

Velocity = $\frac{Change\ in\ displacement}{time}$

If we say 30km/s east, we are talking about displacement, velocity neh. We are talking about what? Velocity. When we say 30km/s east we are talking about velocity. This an example of velocity.

What about example of speed. Speed is distance over time. Distance over what? Overtime. Speed is the distance over time taken.

Teacher writes the following formula on the board:

Speed = $\frac{Distance}{time}$

This is an example of scalar quantity neh. If you are driving a car for example, voom voom…., and people say you driving fast, that is speed. Speed is distance over time measured in kilometres/hour or metres per second. It is a scalar quantity. If a Mr ….. is not driving fast, you tell the driver: please drive fast I want to go and buy …….. (in audible) in Jozi. So speed is an example of scalar quantity. Remember this can also be measured in kilometres per hour or metres per second. Units are very important. We are talking about standard unit.

Ok let us quickly look at force. What is force? People watch this. ***Watch this chalk (*****Teacher throws the chalk upwards and catches on its way down**). *I pick it up. It is a force. Force is a scalar quantity or vector quantity?*

Learner: scalar quantity'

Yes force is a scalar quantity neh. It's a scalar quantity. Why do you say is a scalar quantity?

Learner response in audible

No it is not a scalar quantity. Remember I threw a chalk (teacher demonstrates). There was direction. Force has a direction. A scalar quantity does not have direction. You ……

*Force is an example of a vector quantity. Force is what? Force is mass times acceleration. As I throw the chalk, it goes with a speed. When you multiply mass and acceleration, sometimes the acceleration is linear (*Teacher demonstrates a horizontal movement) *or is acceleration due to gravity which is gravitational force. As I throw it moves with acceleration or acceleration due to gravity which is force. Mass is measured in Newtons. Force is kilograms times acceleration. Force is a vector quantity, it is a measurement of the mass of the body and its acceleration. Every force must have a direction and size. Acceleration is change in velocity over time. The SI unit is the newton (N). the last one we have is weight. What is weight? Wena (you) you are seated neh. Are you not seated? You are seated on a chair, neh. You are exerting your force or weight. If this is a chair and wena (you) are seated on the chair (draws a diagram to illustrate), you are exerting a force on the chair and that force is your weight.*

Let's assume you are 30kg, that 30kg is not your weight. It is your mass. We need to consider the acceleration due gravity. The change in velocity over time towards the centre of the earth. That acceleration due to gravity is 9.8m/s^2.

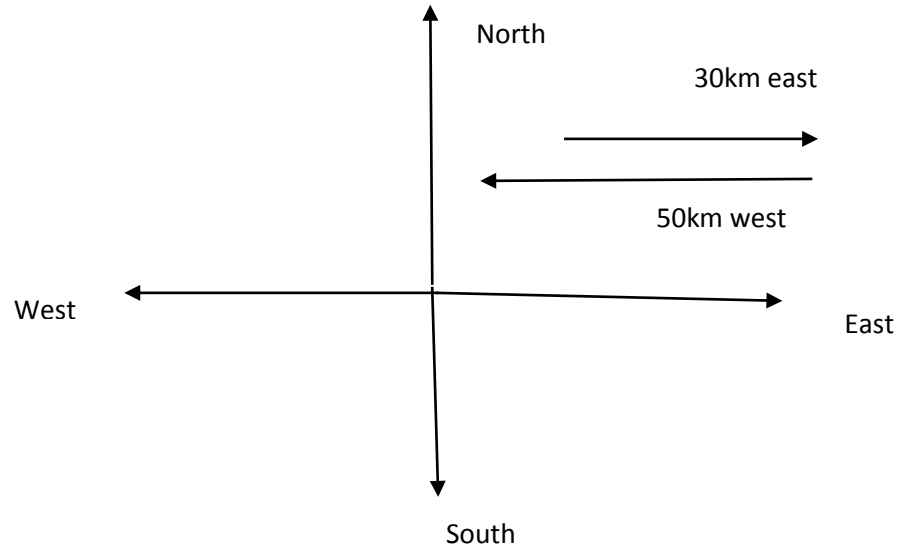
The teacher writes the formula for force and weight:

W = mg

F = ma

Both force and weight and force are the same. This one (F=ma) the acceleration is linear and weight the acceleration is downwards. Let us look at examples of force. Let us look at how we represent vectors. We represent vectors using arrows and using what we call lines. For example, let us look at that. Force is a vector neh. Let us look at vector F_1; 30km east. Let us look at another vector F_2, 50km west.

Teacher draws a diagram to illustrate vectors as shown below:

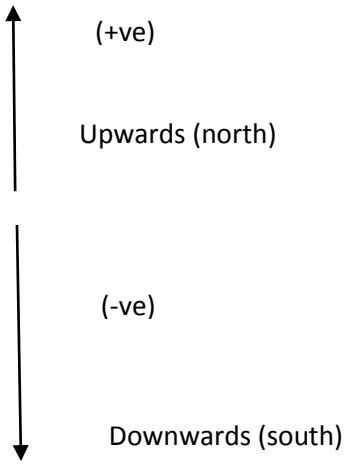


We use the arrows and the lines to represent vectors. The lines represent the what? The magnitude and the arrow represent the what? The direction. And we also try to add to find the solution of vectors.

Let us look at example of what? Let us look at summation of vectors, total of vectors.

Total vector is equal to f_1 plus f_2 (Total vector = $F_1 + F_2$). If a vector is acting upwards, it is positive and if a vector is acting downwards, it is negative.

Teacher draws a diagram to illustrate "total vector".



If a vector is acting upwards, it is upward force or north. This vector is a positive vector. If it is acting downwards, this vector is acting downwards also known as south. This vector that is going south is also called a negative vector. Another way of representing vectors is east and west. The vector that goes to right or the east is called a positive vector. Another vector going opposite to west is called a negative vector.

Lesson 3

Are these vectors are they equal? What do mean by equal vectors?

Learner: …… (not audible)

When we talk of equal, we talking about size, we talking about what? Size. They are same, they are equal forces. But their directions are different. They must be equal forces. You know what is called equal? If F_1 equal to 2N downwards and F_2 is equal to 2N upwards, these force are equal but their directions are different. There are the same forces and same size, equal forces. Equal forces equal vectors, but different directions. These forces are equal but the directions differ. The equal vectors in the sense that their magnitude is the same but their direction is different.

What is a resultant force? The upward force is positive and the downward force is negative.

Teacher does some calculations on the board as follows:

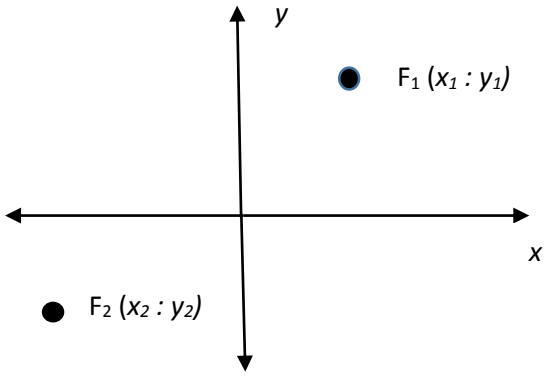
$F_R = 2 + (-2)$

$= 2-2$

$= 0$

Let's look at position. Position is where a particular force is or where a particular vector is located. We normal use what we call cartesian plane.

Teacher draws the cartesian plane on the board.



To locate the position F_1 use the x and the y coordinates. We need to find the x and y coordinates of that force. We need to do what? We need to find the x and y coordinates. For example the position of point F_1 is x against y (x_1;y_1). You can have another force, F_2 acting somewhere, it can determined by the coordinates (x_2 : y_2). You can be asked to determine the position or the distance between two vectors on a cartesian plane. This is the same calculation in maths. You have done this calculation in maths. If are given these two forces on are acting at a position, you can determine their position and also the distance between the distance between the two forces. The distance between the two points is a straight line joining the forces. You know how to determine the distance of the line from maths. How do you determine the distance of the line? How do you determine the distance of the line? What is the distance

Learners not responding and teachers write the distance formula and uses it to calculate the distance between the points after giving coordinates to the two points on the graph for example F_1 (2; 4) and F_2 (-3 ; -3).

*Let us quickly look at what they have in the textbook. There is what we call a frame of reference. A frame of what? A frame of reference. A frame of reference is a set of reference points which has set of axes that enables position of an object to be defined (***Reading the definition from the textbook**). *For example F1 has a frame of reference (x_1 :y_1) and F_2 has a frame of reference (x_2 : y_2). Any object or any quantity that is motion must have a position, must have have a frame of reference. That frame of reference is determined by the x and y coordinates.*

Distance and displacement

What is the difference between displacement and distance? What is the difference? Distance is a scalar quantity and displacement is a vector quantity. Displacement is a vector quantity because it has direction. For example, when we say somebody is 5m away, that is distance. But when we say somebody is a distance of 5m east, thaft is now displacement. Distance can be said to be D = 5m, whilst displacement can be written as Dx = 5m (east). Displacement can also be regarded as distance to the left or right. Displacement, Dx, can be written as $Dx = X_{final} - X_{initial}$. This means $X_2 - X_1$ or change in x.

I will also briefly talk about acceleration. What is acceleration? Acceleration is the rate of change of velocity. Acceleration is measured in metres per second squared. Acceleration can either be positive or negative. Negative acceleration is called retardation, deceleration or declaration. Yes retardation, deceleration or declaration.

Appendix 12

Teacher B Interview Transcript

Researcher: Do you think learners have a problem with language in science?

Teacher: The science language starts with the science dictionary. Most of our learners find the language in science difficult. They need science dictionaries to explain science terms. 60% of our learners do not have basic science or physics background content. More than 60% do not have basic language of science.

Researcher: Do you think language in science is different from everyday language, for example English in general?

Teacher: No, actual there is little difference there, especially the specialised words. They differ a little bit. English language supersedes or controls the science language. The basic language, learners do have it, that is, in terms of meanings of words, the basic understanding or meanings of topics. When we talk of specialised language, like terminology is a problem because the English language does not explain much of those terms in terms of science, especially physics. The English language does not explain deeply or vividly the specialised terms in science, especially physical science. For, example, let me give an example, the focal point. The English explanation of the focal point can be different from the explanation in science. The word is quite different from English, and you need to explain it in science.

Researcher: Do you think teachers are aware that the explanation in ordinary English can be different in science?

Teacher: Teachers actual may not be aware of that, because ……., generally when you are teaching these kids, the mind-set might not always go towards the specialised language, rather the general terms. Teachers are not always aware of this except when we evaluate kids when we find that most of kids have made mistakes one way or the other.

Researcher: Do you think teachers overlook some of the words in science, for example, spontaneous reaction, negligible ……

Resistance (teacher interrupts)

Teacher: Teachers do explain these terms. For example, the word circuit, you need to explain the terms involved or ways in which it is used in electricity to the kids, before you go into detail. There is what we call induction during teaching process. You try to learn what the learner has in mind concerning what you are about to teach. Actual that is entry behaviour. You use that entry behaviour to stimulate your teaching process by explaining those terms. After explanation of those terms, you go into detail of the topic before you start discussing the general topic with kids. So we start from terms, explanation of the terms and you go into detail of the topic which you are about to offer the kids otherwise you may find that at the end of the day you may not realise your objectives of lesson precisely.

Researcher: Do you think teachers contribute to the understanding or misunderstanding of science terms.

Teacher: Yah, yes. Teachers can contribute to misunderstanding of terms or words. It depends on the background of the teacher. Teachers can contribute to the success or failure of the children. If somebody is not specialised in the field of study, he or she may not be carrying the

required standard of that subject. This is why teachers of different fields are being updated to their areas of specialisation. Teachers can easily contribute to the success or failure of the kids.

Researcher: Since you acknowledge that language in science is a problem, how best do you think that can be address on the part of the teacher? What do think the teachers could do to improve the language?

Teacher: The language of science?

Researcher: Yes

Teacher: It depends. Language of science begins on the first phase of learner school work, eh … eh, for example written as the basic foundation. The language of science must be taught from the first time the learner goes to school or the learner enters the classroom. The teacher should try his best to give meanings from textbooks. Actual the textbooks we are looking at here are the dictionary meanings of the specialised words apart from the normal classroom textbooks. If we can get these science dictionaries and give those to the learners that will help learners understand these specialised terms. Even if you are explaining, you refer them to a specific page. Fortunately in our school we are lucky we have these dictionaries. It is unfortunate that the science dictionaries are given to higher grades, for example, grades 11 and 12 whereas those in grade 10 do have the chance to use those dictionaries.

Researcher: Suppose a learner is good in English, do you think that the learner will be automatically be good in science or science language? Does proficient in English translate to proficient in ……..

Teacher: to be proficient in English does not mean that you will be skilful or well in specialised science language. No its not. It's only going to be possible if you inter marry those two together. For example if a learner speaks or knows English well, it does not mean he is going to do well in science if he does not have the required basic terminology to write the science. So the only way is to make sure that in as much as the learner may understand simple English, and use it to answer questions, you can point out to the learners the importance of using this science language in order to interpret the questions or in order to write accurately otherwise if they use general language to answer questions they may not get maximum marks.

Researcher: In other words you are saying there is proficient in the language of instruction and proficient in the science language?

Teacher: Both of them must go together because you cannot do science without the background of the language of instruction. You cannot perform effectively if you do not have the required terminology in science to answer questions in examinations.

Researcher: I just picked up something in one of your lessons when you were teaching about acceleration. You used three words when you were describing negative acceleration. You the words deceleration, retardation, and ……..

Teacher: Yes, I was talking about negative acceleration. I was teaching velocity time graphs, position time graphs and distance time graphs.

Researcher: You used three terms for negative acceleration

Teacher: Yes I used three terms. You call it retardation when it is going down or you call it deceleration when the speed is going down. As I said negative acceleration can be called deceleration, retardation or declaration.

Researcher: I am not sure about declaration. Can you explain the term declaration?

Teacher: Declaration is the opposite of acceleration. But we normal use deceleration in their textbook. But in my textbook which I used back home they also call it declaration. You can also check. They are all the same or similar. They are all synonyms. They are not anonyms.

Researcher: Thank you for your time

Teacher: sometimes learners find it difficult to use the textbook. You can also refer them at the back of the textbook – the index where words are explained. This can be used in addition to the science dictionary