ENHANCING DISCOURSE THROUGH MOTIVATION: A CASE STUDY OF HIGH SCHOOL TEACHING IN SWAZILAND

by

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DECLARATION

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Exact wording of the title of the dissertation or thesis as appearing on the copies submitted for examination:

ENHANCING DISCOURSE THROUGH MOTIVATION: a case study of high school teaching in Swaziland.

I declare that the above thesis is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

______ ________________ 30 January 2019

SIGNATURE DATE

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Abstract

Communication seems to play a pivotal role in any high school classroom. But it was found those classes or certain individual students shy away from engaging in effective communication during natural science lessons in Swaziland. One of the directives in the Swaziland National Education Policy states that syllabuses for studies in Form 4 and 5 should enable learners to develop essential skills which include communication and language skills. This study then, on realising that there was a gap between what was stated in the Education Policy and what was actually the case in the natural science classrooms, sought for a solution that would encourage effective communication in natural sciences. Therefore, the main purpose of the study was to encourage active participation of high school students in natural science lessons. The main research question posed for this purpose was:

Can student motivation enhance classroom discourse for the negotiation of science understanding?

Five sub-questions emanated from the main research question:

(a) How does classroom discourse relate to natural science understanding?
(b) What effect does external motivation have on discourse during natural science lessons?
(c) What is the effect of feedback during natural science learning?
(d) How can feedback be enhanced in the natural science class?
(e) Which teaching strategies improve interactions during natural science learning?

The study is organised into five chapters. The first chapter summarises the whole study by giving the problem statement, research aim and objectives, definition of terms, as well as chapter divisions. Chapter two provides the background to the study through the discussion of education theories based on classroom discourse and motivation. The third chapter presents detailed information about the research design, methods of data

collection and analysis, as well as a proposed method for motivating students. The fourth chapter presents the research results, analysis and discussion. The fifth and the final chapter presents research findings, concluding remarks drawn from the research findings, as well as recommendations for similar future research.

The case study style uses a qualitative, descriptive and exploratory approach. The study concentrated on theories explaining learning and motivation. The sample comprised six purposefully selected students and their two physical science teachers. Data were collected using the standardised open-ended interview and non-participant lesson observation methods, and from documents. The data were collected in two phases, the pre-motivation phase and the motivation phase. The collected data was further categorised into two segments, with each segment being a unit of analysis. One of the segments was composed of oral interchanges, while the other was composed of students' written work. The data was then transcribed, coded, analysed and discussed using the thematic discourse analysis approach. The principles of triangulation, reliability and validity ensured the credibility of the study remained intact. Research ethics were also observed by the researcher and there was trust, respect and autonomy during data collection. The ethics observed included informed consent, confidentiality, beneficence, anonymity and non-malificence. Permission to collect data was sought and obtained from all concerned.

The motivation method helped the physics group improve more (55%) than the chemistry group (7%) in tests. In the overall performance the two groups improved more or less the same: the chemistry group improved by 4% while the physics group improved by 5%. There were three main findings for the study and they revolved around the purpose and the research question. The first major finding was that the motivation method used with the students instilled self-discipline in the students, resulting in self-regulated behaviour and better understanding of science concepts. The finding suggested that motivated students are self-disciplined and take ownership of their learning. The second major finding was that during the motivation phase of data collection interactions improved between the students and their science teachers. These interactions were in the form of classroom talk, submission of school work and feedback. It was inferred that motivated students communicate more effectively and with better understanding of the concepts taught. The third major revelation was that the students were motivated by learner-centred teaching strategies and the use of teaching aids in a science laboratory.

A main finding for the first sub-question was that the more students interacted with each other, with their natural science teachers, and with their books the more they appreciated and understood science concepts. For the second sub-question the main finding was, the motivation method used with the students improved discourse during natural science lessons. The marks the students were awarded gave them the energy to engage more in science activities and to behave well. The main finding for the third sub-question was that prompt feedback and positive comments motivated students to engage more in science discourse and to understand science concepts better. An important finding from the fourth sub-question was that prompt and positive feedback enhanced feedback, as well as giving students tasks that were not too far above their abilities, enhanced feedback in the natural science class. For the fifth sub-question it was found that student-centred teaching methods as well as teaching aids and learning in science laboratories improved interactions during natural science learning.

Key terms: student discourse; teaching/learning styles; extrinsic and intrinsic motivation; purposive sampling; triangulation; non-participant observation; open-ended questions; probing; collaborative teaching methods; social learning theory; thematic discourse analysis.

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Chapter One: Overview of the study

1.1 Introduction

Science subjects in general need people who are inquisitive. People who, if there is something challenging or they do not understand, search for answers and solutions with success; people who readily express their understandings and misunderstandings. Once solutions or information has been found it should then be communicated. This either takes form through speech or written text. Throughout the search process communication is the key (Areekkuzhiyil, 2015). High school in Swaziland requires that students pursuing natural sciences communicate with their teachers through talk, written text and experiments (Ministry of Education and Training, 2019-2020). However, on one hand, the challenge for teachers is that Swazi high school students tend to talk less during science lessons (Sitsebe, 2012; Solem, 2016); yet the nature of the discipline demands that they be active learners. On the other hand, science teachers have an additional challenge of making their lessons interesting for their students by using learner-centred teaching methods (Tanner, 2009).

The purpose of this research was to encourage active participation of students during science lessons, especially through effective communication. The active participation was measured with regard to classroom discourse, meaning, written and spoken communication. The method was based on educational theories such as the social learning theory by Albert Bandura, the theory of assisted learning by Lev Vygotsky, classical conditioning by Ivan Pavlov, as well as operant conditioning by BF Skinner (Ivey, D'Andrea, Ivey & Simek-Morgan, 2009). Science teachers assisted the students to express themselves in class. Some form of incentive was used by the science teachers to encourage the students to ask and answer questions, to contribute relevant information from their own reading, and to do all learning activities effectively. The incentive was half a mark (0.5) for every effort by a student.

Reporting of experiments, which was done as part of school work, fell under classroom discourse. Teachers felt that relevance of the words used during classroom communication to the concept under consideration was another important aspect to be encouraged among students. It informed the teacher about how much knowledge the students had gained in the concept studied.

1.2 Motivation for the Research

The desire to conduct a study on student talk during class time contrived from my observation of students being reserved when learning natural sciences. Other science teachers also motivated me as they would often complain about certain classes or students being too quiet during lessons. The teachers found it difficult to teach shy or reserved students. A big challenge for the teachers was when they had to force those students to talk about science content. And the observation expanded beyond science classes to other subjects as well. Being reserved was a common trait, when teachers asked questions that required abstract thinking. Some hypothesis around the lack of student participation included questioning if it was about content mastery, lack of motivation or any other cause that made students feel reserved. The inference hinted at some form of encouragement needed to be practised by teachers to enhance talking when teaching, especially sciences.

One then became worried about the academic future of such students since knowledge, discoveries and inventions are communicated through talk in formal settings. The students are future leaders of society and needed to be aided from the problem of having communication-related roadblocks during lessons. Finding a solution to the problem would benefit students, society, government and both the academic and professional worlds. As Bandura (1977) proposes, we need not only gain knowledge by observing others, but we also need to reproduce what we have learnt. Such social constructivist practices need to be cultivated among learners while they are still young. It was for this reason that I decided to devise a strategy for encouraging communication between teachers and students during lesson time.

Communication is key to every school lesson and this study aimed at enhancing the same. Student discourse, as used in this study, meant the language students used when interacting with each other or with their teacher (Gee, 1996 & Hardman, 2016). In a science class the teacher's main task is to teach the students how to talk, what to do, how to read, write, interact and even think science as a social activity. For this study, both everyday and science discourses were enhanced; but mostly the science discourses. The science teacher is expected to help the students move from the left of the continuum, where there are social/everyday discourses, to the right of the continuum, where there are classroom/science discourses. The teacher's main task is to mediate scientific thinking within the zone of proximal development (ZPD) using scientific language to the students who are learning to talk, read and write science (McCown, Driscoll, & Roop, 1996; Khatib, 2010).

What made things worse for Swazi students was that the sciences were taught in English, which was not their mother tongue but a second language. Contemporary natural science educationists support the view that culture encompasses language; thus Swazi students join a new culture in a natural science class to learn the scientific language in English (Brown, Reveles, & Kelly, 2005; Gose, 2013). Language is the means to construct interactions in the classroom and is central to scientific literacy. Therefore, science students develop science literacy through classroom conversations. The students should consider their teacher as a more capable peer with whom meaning is constructed through shared discourse (Rollnick, 2000; Ruiz de Mendoza & Gómez González, 2014). Language is therefore very important in the natural science classroom as it mediates interactions and knowledge acquisition.

Students help each other develop science literacy by extending each others' understanding. The natural science teacher plays a vital role in developing science literacy in students by either affirming or restating their responses. The teacher also assists them by prompting and validating their responses as they build each other's responses. The teacher's praises and prompts (external motivation) encourage the students to contribute knowledge in a way they may have not done before. The teacher and students construct new science understanding through such dialogues; both are expected to use relevant technical terms to flow with the same tide. The teacher's assistance is very important for the students who are still learning natural science, as there is a close association between language, science learning and identity. Park (2016) recommends rapport-building during teacher-student interactions through various strategies like engaging students in informal conversations, integrating humour into classroom interactions, softening corrections with compliments and demonstrating empathy toward students.

Student discourse includes reading through practise of active and critical reading of science text. Critical reading may be accompanied by arguing how ideas are supported by evidence (Osborne, 2002) – which may be experiment results for a natural science class. Their teacher needs to emphasise the importance of using appropriate scientific vocabulary (Wellington, 2006). The teacher is also expected to teach the science students with enthusiasm using different teaching strategies and interdisciplinary instruction (Akerson, 2001; http://www.ltscotland.org.uk/learningteachingandassessment/learningacrossthecurriculum/interdisciplinarylearning/a bout/contextforlearning.asp). The natural science teacher is expected to enhance students' discourse by the purposeful use of English language for effective communication of scientific ideas through reading, writing, speaking and listening. This develops their oral skills through a shared experience, where the students can report their scientific investigations in the classroom, as well as argue their perspective or findings because scientific knowledge changes with new investigations and evidence.

A notable factor that was considered about the participants of the study was that they had three languages with which to cope. Their mother tongue was SiSwati, their second language English, and the scientific language. Their main challenge as bilingual students was comparing and contrasting SiSwati and English in a semantic, cultural and social sense as they interacted during science lessons. Interference between SiSwati and

English was another main problem, as understanding in one language interfered with understanding in the other. Interference existed even between everyday English and the scientific language and equally between SiSwati and the scientific language. The natural science teachers had the task of assisting the science students with understanding as they switched from one language to the other. The proposed method for motivating student discourse during the science lessons was expected to improve not only knowledge acquisition, but also language skills. This method of motivation is described in the following chapter: Research Methods and Design.

1.3 Problem Statement

Classroom discourse is very important, since the teacher quickly corrects any misconceptions among the students before they are established in their long term memory. In fact, discourse in class is like the circulatory system in the human body which supplies all the body cells with the materials essential for life, and at the same time removes all unwanted (toxic and excess) substances out of the body. Should such an indispensable system fail, death is practically guaranteed. Imagine the difficulty of teaching a group of students in a main stream class, who are reluctant to talk and write during class time. Immediate feedback on how effective one's teaching is can be obtained from what the students say through their writing or participation. Indeed, discourse in any classroom is like a compass to a ship captain or someone in the desert. Everyone is informed by what they see, hear, and say. It is often common for a teacher to complain about students who do not want to talk or participate actively in lessons.

The scarcity of discourse during class time jeopardises not only the students' academic lives but also limits the teacher's professional growth. It would indeed be difficult for any teacher to go back to such a group of students day after day if they continue with their reluctance to communicate during class time. A teacher's drive could be rekindled by going back to such a group of students, with encouragement strategies to make them communicate during class time. Such a group would need immediate attention not only by the respective classroom teacher, but also of other stakeholders such as guidance and counselling experts. Communication is not important only at school level but also at higher levels of academic and professional life. New scientific and technological discoveries and inventions are communicated through talk and writing with other scientists, and finally with the general public. Communication skills therefore are essential to one's development. Therefore, this study sets out to motivate the type of aforementioned students to communicate effectively during class time.

The problem for this research was stated as follows:

How can student motivation enhance classroom discourse for improved natural science understanding?

This main research question was addressed through the following sub-questions:

(a) How does classroom discourse relate to natural science understanding?
(b) What effect does external motivation have on discourse during natural science lessons?
(c) What is the effect of feedback during natural science learning?
(d) How can feedback be enhanced in the natural science class?
(e) Which teaching strategies improve interactions during natural science learning?

1.4 Research aim and objectives

The main aim of the study was to motivate high school students to communicate effectively during natural science lessons. The study was therefore structured to achieve the following objectives:

- to find out how classroom discourse relates to natural science understanding;
- to find out the effects of external motivation on discourse during natural science lessons;
- to assess the effect of feedback during natural science learning;

- to explore ways of enhancing feedback during natural science learning;
- to find out which teaching strategies improve interactions during natural science lessons.

1.5 Definition of terms

Key terms that appear in the topic are discourse, motivation and case study.

- Moje, Collazo, Carrillo & Marx (2001) define discourse as a way of knowing, doing, talking, reading, and writing. It is what a student draws on to talk about, write about, and represent knowledge (Gomez, 2007).
- Motivation is defined by Brennen (2012) as the level of effort a student is willing to expend towards the achievement of a certain goal.
- Lastly, case study refers here to the in-depth analysis of one Form 4 natural science class (MacMillan, 2004).

1.1 Chapter divisions

The rest of the chapters naturally end in a summary.

- Chapter 1 has the background, introduction, aims and limits of the study. The background gives an overview of the entire study. The introduction then states what the research is all about, and why the researcher chose to do the research. Effort is made to convince the reader that the study is topical and valuable. The aims of the study are stated and the important concepts described. These concepts include discourse, motivation and case study. The limits of the study are stated.

- The second chapter gives a review of the relevant literature. It begins with an overview of the concepts to be reviewed. Relevant literature is then discussed on the basis of how much research on the subject has already been conducted and what lessons can be gleaned from it. Both primary and secondary sources are consulted for literature.

The literature review is mostly on student discourse and motivation. Educational theories on student motivation are discussed. The chapter provides the background for the study.

- Chapter 3 presents the research design and methods in detail. The chapter begins with an overview of the contents to be addressed. The study exploits qualitative research methods. Data collection methods are explained together with the proposed method for motivating students to engage actively during science lessons. Sampling methods are also discussed in detail.

- The results of the research are handled in chapter 4. The chapter begins with an overview of its contents. It covers data presentation, analysis and discussion. The data are analysed and discussed in reference to the reviewed literature.

- The last chapter encompasses the findings, recommendations and concluding remarks. The concluding remarks are drawn from the research findings, while the recommendations are made with regard to similar future research, based on strengths and weaknesses of this study.

Chapter Two: Literature Review

2.1 Introduction

In this chapter, literature related to the motivation of high school natural science students is reviewed. Literature is discussed on the basis of how much research has already been conducted in this field of study. Related literature was reviewed for purposes of: (a) refining the research problem; (b) developing justification for the research; (c) identifying methodological techniques; (d) identifying contradictory findings; and (e) learning about new information (McMillan, 2004).The literature reviewed was mostly on student learning and motivation. This chapter provides the background for the study. The literature was used for reference purposes when collecting and analysing data; and also when interpreting the results in the subsequent chapters. This chapter framed the whole study and assisted the researcher in making conclusions and recommendations for future research. The literature is reviewed under three main themes: teaching and learning; student discourse; and motivation. Both primary and secondary sources are consulted for literature.

2.2 Overview of the reviewed literature

There were four major concepts reviewed in this chapter: (1) classroom discourse, (2) teaching and learning, (3) andragogy and pedagogy, and (4) motivation. This section gave the theoretical underpinning of the study. The context of the study was a collection of discourses in a high school natural science classroom in Swaziland. Theories that pertained to teaching, learning and motivation were discussed in relation to classroom discourse. Learning was discussed based on conditioning, cognitive and social aspects; with more emphasis on the social aspect of learning, as depicted by Albert Bandura (Grieve, Deventer, & Mojapelo-Batka, 2011). Social learning was chosen as the main form of learning to characterise the study, because it encompasses even associative and cognitive learning processes. Social constructivism thus formed the basis of the study.

Teaching strategies that suited the natural science learner were discussed. Teaching and learning styles suitable for the science learner were also discussed. Patterns of classroom discourse were covered in relation to high school natural science lessons. Andragogy as a means of encouraging student discourse during learning was explained. Challenges to learning, experienced by natural science learners, were considered. The importance of motivation during the teaching and learning process was discussed - with the science learner as the centre of focus.

2.3 Student Discourse

By student discourse the researcher meant the language students use when interacting with each other, or with their teacher (Gee, 1996; Hardman, 2016). The term discourse was used in this study to mean the use of language (Mingfong, Yam San & Ek Ming, 2010). According to Langman and Fies (2010), the use of language or discourse is key to science education.

Student discourse within the classroom is sometimes called classroom discourse. Areekkuzhiyil (2015) identifies three patterns of classroom discourse, namely, silent, controlled, and active classroom discourse. Silent classroom discourse refers to the situation where the teacher talks almost the entire time, and occasionally asks a question. In controlled classroom discourse, the teacher is the one who asks questions; the students only respond to the teacher’s questions. The students thus become passive recipients of knowledge in that aspect of classroom interactions (Solem, 2016). Finally, in active classroom discourse, the students talk to each other while their teacher only facilitates their discourse. Active classroom discourse was in line with the policy by the Ministry of Education and Training (Swaziland) of encouraging teachers to adopt learner-centred teaching approaches. The adoption of learner-centred teaching approaches would transform the education systems practised in most African rural schools to discourses and pedagogies that enable students to achieve better (Ngwaru, 2011). It would be a move away from the use of behaviourist-based pedagogical approaches to principles of transformative and constructive developmental pedagogy.

2.3.1 Types of discourse

Discourse is either dialogic or authoritative (Mortimer, 2005; Hardman, 2016). Dialogic discourse is open to different perspectives in an attempt to acknowledge and understand the perspectives of others. Dialogic discourse is suitable for most learner-centred teaching approaches, such as the co-operative approach. Through dialogic discourse the teacher attends to the students' points of view, as well as to the school science view. At the start of a lesson sequence, the science teacher may use dialogic talk to elicit students' everyday views about a particular concept, and compares them with the school science view. Later on in the sequence, the teacher may encourage students to talk about the application of a newly-learned scientific idea. Students too extend each other's knowledge acquisition and understanding through dialogic discourse. Science students' investigations in the science laboratory should be dominated by dialogic discourse (Mortimer, 2005).

Authoritative discourse on the other hand, does not allow the convergence and exploration of ideas. The teacher just focuses attention on the school science point of view. Should students raise ideas or questions which do not contribute to the development of the school science view, those ideas or questions are likely to be reshaped or ignored by the teacher. Alternatively, if a student's idea is perceived by the teacher as being helpful to the development of a scientific concept, it is likely to be seized upon and used. In these ways authoritative discourse is prohibitive in nature. Different students may make contributions but there will be no exploration of their different perspectives by the teacher (Mortimer, 2005). In the context of everyday conversation, authoritative discourse might occur, when two people talk about their ideas, without listening to what the other is saying (ibid).

In the teaching and learning process, both dialogic and authoritative discourses are essential. Dialogic discourse is crucial when handling everyday and scientific views for meaningful learning. On the other hand, the teacher has the responsibility for introducing the authoritative discourse of science to the students. Therefore, even when the teacher is asking students for their points of view about a particular concept, they shall inevitably be thinking about how this relates to the science view. A motivated science class is thus expected to use both dialogic and authoritative discourses for meaningful learning. Likewise, a teacher can motivate a group of students by allowing both dialogic and authoritative discourses during lessons (Mortimer, 2005). Therefore, the teacher's main task is to teach students what to do, how to talk, read, write, interact, and even think scientifically as science is a social activity (ibid).

Everyday discourse becomes handy when explaining challenging and abstract concepts to students. Everyday discourse refers to the language used mostly outside the classroom. The science teacher is expected to help students during knowledge construction (a metacognitive process) so that they move from the left side of the continuum, where there are social/everyday discourses, to the right side of the continuum, where there are classroom/science discourses. The teacher's main task is to mediate scientific thinking within the zone of proximal development (ZPD), using scientific language to the students who are learning to talk, read and write scientifically (McCown et al., 1996; Gose, 2013).

2.3.2 Benefits of Student Discourse

Teaching of sciences in English puts Swazi students at a general disadvantage as it is not their mother tongue, but a second language for them. Moreover, as contemporary natural science educationists support the view that culture encompasses language, Swazi students thus join a new culture in a natural science class to learn the scientific language in English (Brown et al., 2005). This language is the means for constructing interactions in the classroom and is central to scientific literacy. Therefore, classroom discourse helps science students develop science literacy through classroom conversations. During the development of science literacy students should consider their teacher as a more capable peer with whom they construct meaning through shared discourse (Rollnick, 2000; Ruiz de Mendoza & Gómez González, 2014). Language or discourse is therefore very important in the natural science classroom since it mediates interactions and knowledge acquisition (ibid).

Students help each other develop science literacy by extending their understanding through discourse. Their teacher assists them by prompting and validating their responses as they build on one another's responses. The natural science teacher also plays a vital role in developing science literacy in students by either affirming or restating their responses. The teacher's praises and prompts (external motivation) encourage the students to contribute knowledge their teacher may not think they have. The teacher and the students construct new science understanding during such dialogues; and are expected to use relevant technical terms for them to flow with the same tide (Rollnick, 2000). The teacher's assistance is very important to the students who are still learning natural science, as there is a close association between language, identity and science learning (ibid).

Student discourse is again beneficial as the process helps solve some of the pressing challenges in education. It plays an important role in helping the learner shift from shallow to deep comprehension, and from being a fact collector to being an inquisitive explainer (Nuthall, Graesser & Person, 2012).Through student discourse the teacher engages the students' minds and gets insight into their knowledge and capability. Based on these insights, the teacher may then improve their curriculum.

2.3.3 Ways of Promoting Student Discourse

Student discourse in the science classroom can be promoted through talk, writing and reading (Nuthall et al., 2012). Some of the methods for improving data comprehension that help to achieve this are: (1) asking students to generate their own explanations when listening to lessons or when reading text; (2) asking questions; (3) challenging a learner's beliefs and knowledge; and (4) tutoring (ibid). The following paragraphs cover the methods for improving data comprehension under the subheadings ‘Talking as Discourse’, Reading as Discourse’, and ‘Writing as Discourse’.

2.3.3.1 Talking as Discourse

Talking improves and promotes discourse. Talking is an important part of learning because it enables students to process new information (Tanner, 2009). Student talk is also the core of many active, innovative and inquiry-based approaches to teaching. Teachers also get to know students’ confusions, ideas and wonderments through student talk. Teachers regard student talk as important because it: (1) enriches the individual student’s learning experience; (2) improves the nature of a large class; (3) provides teachers with insight into students’ cognition; and (4) promotes a collaborative, rather than competitive, culture among students (ibid.). Different types of talk, such as self-explanation, arguments, storytelling, one-to-one tutoring, information-seeking questions, and current and controversial issues help to achieve the above four aspects (ibid.).

2.3.3.1.1 Self-explanation

Talk facilitates the integration of new knowledge into existing knowledge through a cognitive process termed self-explanation (ibid). De Jong (2001) defines self-explanation as the integration of prior knowledge with new information in order to come up with a functional generalisation for the learning process. It is the explanation a learner generates on his or her own rather than the explanation(s) provided by an external source (Ionas, Cernusca, & Collier, 2012). Self-explanation is one of the ways by which we learn. Learning is a constructive process in which a learner converts words and examples generated by a teacher or presented in a text, into usable skills, such as solving problems (Chi, Bassok, Lewis, Reimann, & Glaser, 1989). This process of conversion is a form of constructive self-instruction. Tanner (2009) reports that an analysis of numerous studies reveals increased achievement after learning among students who give explanations, compared to those who receive explanations. In fact active engagement in learning activities has proved to be more beneficial to students than passive learning (Thompson, 2013). However, the prime responsibility of the teacher is to provide classrooms and laboratories that are safe to students so that they can offer their ideas, even if based on misconceptions, without fear of ridicule. Talking is the main medium through which most teaching occurs in the classroom (Tanner, 2009). Students need to ask themselves questions such as why, how, what if and what if not, in order to generate explanations. They can also be encouraged to ask and answer deep-reasoning questions (ibid.).

Self-explanations enable students to make appropriate connections among concepts in a domain. When learners receive new information they need to relate it to knowledge they already possess, then use the prior knowledge to understand the new concepts, and finally synthesise new knowledge (Ionas et al., 2012). This improves the understanding of new concepts. Self-explanation statements are categorised into seven groups (Ainsworth & Burcham, 2007):

1) Principle-based explanation: the learner elaborates on a concept according to an underlying domain principle (e.g., this is due to diffusion as molecules are spreading from a greater concentration to a lesser concentration).
2) Goal-driven explanation: the learner makes an explanation that infers a goal to a particular structure or action (e.g., valves of the heart prevent blood flowing in the wrong direction).
3) Elaborative explanations: the learner infers information from a sentence in an elaborated manner. Metaphors, analogies, and elaborations that link prior material to new ideas are classified in this category (e.g., the skeletal muscles squeeze the blood in the blood vessels in the right direction, somewhat like a hand squeezing toothpaste out of a tube).
4) Noticing coherence: the learner notices an association between a previous concept and the current material without elaborating.
5) Monitoring- negative/positive: the learner states that he or she did or did not understand the material presented (e.g., Okay. That makes sense or I didn’t really understand that).
6) Paraphrasing: the learner restates the information presented in his or her own words.

7) False self-explanation: the learner self-explains one of the previous categories but the explanation is incorrect.

A combination of principle-based explanations and paraphrasing has greater gains for learners (Ainsworth & Burcham, 2007). In their study Ainsworth and Burcham (2007) also noted that students who self-explain have greater gains in tests than students who do not. Self-explanation strategies improve student understanding and thus learning (Bielaczyc, Pirolli, & Brown, 1995). Ionas, Cernusca, and Collier (2012) report that self-explanation is thought to be more effective than explanations provided by others or gathered by the learner from other sources (e.g., textbooks) because (a) it requires learners to actively elaborate their prior knowledge, thus triggering more constructive learning processes; (b) it is usually well targeted to the learner's specific problem; and (c) it is always available exactly when and where the learner needs it.

Three claims that make self-explanation work for subjects such as sciences are that (a) self-explanation seems to persuade learners to detect gaps (a state of disequilibration) and then fill those gaps in their own knowledge – realisation of the zone of proximal development (first described by Vygotsky in 1978), (b) self-explanation seems to help learners to abstract solutions and procedures from the initial context in which they were generated to a more general description of the problem, and (c) it seems to induce an analogical enhancement, a richer elaboration of the example or case, facilitating later analogical problem solving (Ionas et al., 2012). Self-explanation is an active-learning strategy which significantly improves student understanding and learning (Hake, 1998) and serves as a check on one's understanding. When students are unable to construct an explanation, this means that they have detected a gap in their knowledge. If they can fill in the gap, new knowledge is constructed (Vincent, Aleven, & Koedinger, 2000).

2.3.3.1.2 Arguments

Ortega, Alzate & Bargallo (2015) define argumentation in a science class as a dialogic process used for the co-construction of more meaningful understandings of the concepts discussed. Llewellyn (2013) defines scientific argumentation as a process of generating, verifying, communicating, debating, and modifying explanations. Driver, Newton, & Osborne (2000) define arguing as a human practice that takes place within a specific community. The main aim of argumentation is the *rational* resolution of questions, issues and disputes. Thus, arguments are at the heart of science and are considered central to the discourse of scientists. Argumentation is their way of persuading others to realise the validity of their claims. Scientists also engage in arguments as a mechanism for conceptual growth and change.

Scientists use language as a tool for social interactions and meaning-making (Barnes, 1992; Berk & Winsler, 1995; Hardman, 2016). In fact, argumentation has been called the language of science (Duschl, Ellenbogan, & Erduran, 1999). When applying this perspective to a science classroom, it results in the view that scientific knowledge is socially constructed, negotiated, validated, and communicated in the context of the specific discourse practices of science (Driver, Asoko, Leach, Mortimer, & Scott, 1994; Hardman, 2016). It is through the process of exposing different interpretations and checking them against available evidence that scientists, and eventually the public, gain confidence in the knowledge claims that are made. Argument is thus the mechanism of quality control in the scientific community.

Scientists engage in arguments as a way of reaching a consensus about the validity of their claims. Scientific claims progress by theories being open to challenge through dispute, conflict, and paradigm change (Driver et al., 2000). A claim is a constitutive feature of an argument. Toulmin (1958) identified six components of an argument:

(1) *Data:* these are the facts that those involved in the argument appeal to in support of their claim.
(2) *Claim:* this is the conclusion whose merits are to be established.
(3) *Warrants:* these are the reasons (rules, principles, etc.) that are proposed to justify the connections between the data and the knowledge claim, or conclusion.

(4) *Backing:* commonly agreed basic assumptions that provide the justification for particular warrants.

(5) *Qualifiers:* these specify the conditions under which the claim can be taken as true; these conditions then represent limitations on the claim.

(6) *Rebuttals:* the conditions when the claim will not be true.

However, Toulmin's analysis of an argument has limitations in that (Driver et al., 2000):

> (i) the same statement may have a different meaning in a different context, so the context needs to be taken into account in inferring meaning; (ii) parts of arguments such as warrants are often not explicitly stated in speech but are implicit; (iii) in the natural flow of conversation points are not necessarily developed sequentially and reference has to be made across extensive sections of the text to identify features of the argument; and (iv) not all points are made through speech as some are made through semiotic gestures, pointing at objects, nodding, etc., especially in science where manipulable materials are used. Moreover, illustrations and graphics are no longer supplementary but a central communicative feature of texts.

Arguments can be classified as rhetorical, dialectical, or analytical (Duschl & Osborne, 2002). Rhetorical arguments or didactic arguments are one-sided and frequently discursive in nature, and are used to persuade others by presenting one point of view as more convincing than its alternatives. Examples of such arguments are common in science lessons in which a teacher provides a scientific explanation to a class or to a group of students with the intent of helping them to see it as reasonable (Driver et al., 2000; Armstrong, Moyer & Stanton, 2006). The science teacher will rely on traditional authority (where teachers draw on their institutional positions for support) to substantiate knowledge claims when arguing in this way. The rhetorical form of argument is one-sided and has limitations in educational settings since contemporary science classrooms need to offer opportunities to students, to practice reasoning for themselves. This will enable students to articulate reasons for supporting a particular claim; to attempt to persuade or convince their peers; to express doubts; to ask questions; to relate alternate views; and to point out what is not known (ibid.).

Dialectical arguments are also referred to as dialogical or multi-voiced arguments. Their purpose is to reach an agreement on acceptable claims or courses of action (ibid.). Dialogical arguments can take place between individuals or within social groups. Constructing such arguments involves considering alternative positions. Even arguments constructed by an individual are based on cases that their arguments must contest, and which consider differing perspectives offered during debate or discussion. The practice of argument by students in groups is an important mechanism for scaffolding the construction of students' individual arguments (Driver et al., 2000). Teachers who engage in dialogical arguments rely on rational authority (where teachers supply reasons and evidence for knowledge claims) to substantiate knowledge claims when arguing (ibid.). Analytical arguments follow the rules of logic and may be inductive or deductive (Duschl & Osborne, 2002; Yore, 2003). Inductive arguments include analogies and causal correlations, while deductive arguments include syllogisms and causal generalisations (Duschl & Osborne, 2002). Current science education reform emphasises the use of dialectical and analytical arguments over rhetorical arguments, which traditionally have been predominant in the classroom (Driver et al., 2000). This form is in line with the central goal of science education, which is to persuade students to seek evidence and reasons for the ideas we hold, and to take them seriously as a guide for belief and action.

In a science classroom students can be put in a state of cognitive disequilibrium by posing questions that challenge some of their entrenched beliefs. This causes students to ask many questions and pose counterarguments (Tanner, 2009). Science teachers then have the responsibility to train their students to engage in productive debate. Teachers need to value and learn how to implement group discussions and prompt justification before they can orchestrate effective counter-arguments within their teaching (Osborne, Erduran & Simon, 2004b). Their students need to learn how to listen and talk, justify claims, etc. before they can debate (ibid.). Science teachers need to give their students opportunities to explore their own arguments for different perspectives on contemporary issues and the ensuring disputes. These opportunities help students develop the confidence and skills in argument necessary for making life decisions and for contributing as citizens of a democratic society (Driver et al., 2000).

Offering an argument is complicated because an argument consists of many small parts. Every argument should contain five elements: a statement, a definition, reasoning, evidence and impact (Bettivia, 2011). A "statement" is a sentence summarising what an argument is about, not unlike the heading at the beginning of a section in a textbook that lets you know what to expect in the pages that follow such as "oranges are better than apples because they are a good source of vitamin C". In an argument "definition" refers to the meaning given to a word for purposes of debate. A definition expands on the statement and gives context for the argument. Sometimes a statement needs considerable definition, and other times very little. "Reasoning" explains the logic or thought processes behind the argument. For example, one convinces a judge to care about one's argument by providing explanations. Assuming the judge cares or has concerns about the issue at hand maybe a mistake, thus the need to explain every detail of the argument fully. Explanations should be supported by evidence, and it is always good to supply multiple pieces of evidence when arguing. Other pieces will be used for backing up the argument, should the other side try to challenge it. Evidence could take the form of statistics, expert opinion, or contemporary and historical examples.

The last element of an argument is "impact" which refers to the connection between the argument and possible short- and long-term consequences. Impact can be described negatively by describing the bad things that could happen if a judge doesn't listen to an argument, or .it could be done positively by highlighting the good that could result if a judge listens to an argument. All five elements are needed to make a single complete argument.

Science is not built on observations and experiments; in fact they generate arguments in support of knowledge claims (Driver et al., 2000; Armstrong, Moyer & Stanton, 2006). Scientists judge competing knowledge claims and determine whether or not to accept them on the basis of the strength of arguments and their supporting data. Consequently, arguments enable students to understand the basis of the knowledge claims with which they are confronted. In addition, they help students to both construct and analyse arguments relating to the social applications and implications of science (Dewey, 1916; European Commission, 1995).

2.3.3.1.3 Current and controversial issues

Controversial issues are ‘Issues which arouse strong feelings and divide opinion in communities and society’ (Papamichael, Gannon, Djukanovic, Fernández, Kerr & Huddleston, 2016). A controversial issue involves a problem about which different individuals and groups urge conflicting courses of action (The School District of Torrington, 2010). Examples of controversial issues include extremism, gender violence, child abuse, or sexual orientation. Young people can be frustrated or confused about some of the major controversial issues which affect their communities, especially if they find themselves unable to voice their concerns, are unaware of how others feel or are left to rely on friends and social media for information. Social media alerts young people to information and images which influence their world-view, negatively at times (Huddleston, 2003). Teaching students at school how to engage in dialogue with peers whose values are different from theirs is essential for the protection and strengthening of democracy and for fostering a culture that values human rights. Teaching them to discuss their differences in a rational way in primary years will make them more likely to accept differences as normal in their adolescence (Huddleston, 2003).

In fact, teaching young people good citizenship equips them to deal with situations of conflict and controversy knowledgeably and tolerantly. It helps to equip them to understand the consequences of their actions, and those of the adults around them. Students learn how to recognise bias, evaluate argument, weigh evidence, and look for alternative interpretations, viewpoints and sources of evidence (Huddleston, 2003). They also learn to give good reasons for the things they say and do, and to expect good reasons to be given by others.

Some parts of the world experience high-profile incidents of violence and social disorder making the handling of controversial issues in schools a matter of educational urgency

(Huddleston, 2003). These are incidents such as the 2011 London riots, the 2011 Norwegian hate crimes and the Charlie Hebdo attack in Paris in 2015 (Papamichael et al., 2016). In South Africa there are bouts of xenophobia despite the post-apartheid era.

Current and controversial issues are also good for engaging students in debate, since they often stimulate student interest in science (Van Rooy, 1994). They usually lead to heated group or whole-class debates because of the potential to link previous and current controversial issues, causing students to challenge contemporary concepts and beliefs. Such debates help science students develop communication and listening skills. Their scientific knowledge of the subject content also improves; in order for them to argue rationally they need mastery of the concepts under debate (Green, 2007). At the same time students develop an appreciation for science and view it as a dynamic and exciting field of study. Disagreements arising from controversial issues help science teachers elicit students' prior knowledge about disputed concepts (Green, 2007).

2.3.3.1.4 Information-seeking questions

A question is a written or oral linguistic expression of a problem at hand, uttered with the intention of inducing a response (Saracevic, Kantor, Alice & Trivison, 1988; Watson, 2018). To stimulate students to engage in constructive classroom discourse teachers need to ask genuine information-seeking questions. These are questions inspired by contradictions, anomalies, obstacles to goals, uncertainty and obvious gaps in knowledge (Nuthall et al., 2012). During such communication, vision and prosody become closely associated because of the important role facial expressions in linguistic interpretation (Srinivasan & Massaro, 2003, Borras-Comes & Prieto, 2010). This makes it very important for teachers to stand where they can be seen by all students when they are talking, particularly with visual learners. The language used is another important factor, as some language users rely more on facial cues than others (Crespo-Sendra, Vanrell & Prieto, 2010).

A teacher will ask information-seeking questions necessary for solving problems, making decisions, or improving understanding to elicit responses from students (Saracevic et al., 1988). Students' failure to answer the teacher's questions satisfactorily puts them in a state of cognitive disequilibrium. Once teachers have created that state, then they should provide useful information when students ask questions (Nuthall et al., 2012).

2.3.3.1.5 One-to-one tutoring

One-to-one tutoring can also be used by teachers to improve student discourse within the classroom (Nuthall et al., 2012). Tutoring, since it involves a turn-by-turn collaborative exchange between the tutor and the student appears to be superior to normal learning experiences (ibid.). Peers are usually the best tutors since their discourse hinges on collaborative problem-solving, question-asking and answering, and explanation-building in the context of specific problems, cases and examples (ibid.). Discourse patterns of formal lessons tend to use more complicated discourse than ordinary tutoring.

2.3.3.1.6 Storytelling

Teachers can also use storytelling as a teaching method that promotes student discourse (Stein & Hussong, 2007). It is a good technique which caters to all learning modalities (i.e., visual spatial, auditory, kinaesthetic and symbolic abstract). Learning modalities are preferences among sensory modes favoured for individual learning purposes (Samples, 1994). Storytelling is a powerful form of communication in most African cultures, especially in Swazi culture. In Swaziland traditions and culture are passed from generation to generation through storytelling and practices. Therefore, a science concept introduced to a Swazi student through storytelling becomes deeply rooted and remains in that student's long-term memory. Motivating a student's interest in a concept taught develops positive expectations in the student for subsequent science concepts (Samples, 1994).

A teacher will introduce a concept by telling a story if there is a problem to be solved, a conflict to be resolved or the prospect "What if…?" (Stears & Malcolm, 2005). The storyline approach caters to all four learning modalities when implemented using the launch, explore and summarise (LES) instructional mode (Isabelle, 2007). During the 'launch' phase the teacher can probe questions, display models or provide visual displays to activate students and elicit their prior knowledge of the concept to be investigated. This activity caters to all learning modalities, provided the teacher also writes down questions in addition to asking them orally. A brief discussion of the concept may help students before the teacher moves on to the 'explore' phase (ibid.).

During the 'explore' phase the teacher may give each student a copy of a story with the history of the concept. The copy will benefit the visual learners as well as those who prefer symbolic codes. The teacher may then read the story, thus benefiting auditory learners. While reading the teacher can use an overhead/data projector to display a diagram to help create a visual context of the historical event. A model can help the students create a clearer picture of the concept. The teacher can then hold another discussion with the students about what is factual and what is not. The discussion can benefit kinaesthetic students as they play out some of the scenes during discussion, and accidentally benefitting other students with other learning modalities (Isabelle, 2007).

2.3.3.2 Reading as discourse

Student discourse includes reading as well. Lyon (2000) considers reading as an activity critical to the overall well-being of a child. Reading involves the decoding and comprehension of written text, and to read efficiently a child needs to be aware that spoken words are composed of individual sound parts termed phonemes. They should also be able to link sounds with letters (phonics skills) (ibid.). What makes a language like English difficult to read is that some phonemes in some words are not pronounced. An example would be the word bag in which the /a/ and the /g/ are folded into the /b/ when speaking. Thus, the acoustic information presented to the ears reflects an overlapping bundle of sound, not three discrete sounds. This process is believed to improve communication by making it rapid and efficient (Lyon, 2000), yet making it stressful to a student whose mother language is SiSwati. SiSwati is different from English regarding the pronunciation of words, in that all phonemes are pronounced in SiSwati. A learner who cannot acquire fluency and automaticity in reading a language will not understand and enjoy reading that language.

Students are expected to practise active and critical reading of science text. Critical reading may be accompanied by arguing how ideas are supported by evidence (Osborne, 2002) – the evidence may be experimental results for a natural science class. Their teacher needs to emphasise the importance of using appropriate scientific vocabulary (Wellington, 2006) as they argue their point. The teacher is also expected to teach the science students with enthusiasm using different teaching strategies and interdisciplinary instruction (Akerson, 2001; Lederman & Abell, 2014); such as the purposeful use of English language arts for effective communication of scientific ideas through reading, writing, speaking and listening. This will develop their oral skills through shared experience so that they can report their scientific investigations in the classroom, as well as argue their point of view or findings because scientific knowledge changes with new investigations and evidence. Otherwise the hope for a fulfilling and productive life of a youngster who cannot read diminishes (ibid).

2.3.3.3 Writing as discourse

Written text conforms to rules that most successful writers unconsciously follow and native readers unconsciously expect to find (Hadley, 2015). Written communication is different from spoken communication in that it offers more chances of planning and preparation; implying more precise ordering and organisation of text (Martinkova, 2013). Written text is also more complex than spoken discourse because of the more compact and even fused structures that make it. This usually results in sentences that are longer. Written text maintains context and expressivity, though not as good as spoken communication. In official environments written text serves a more prestigious function (ibid). Written academic text has culturally determined and socially accepted structures to help students identify and reproduce specific genres. Written discourse also has a higher frequency of specific grammatical structures such as ‘the second point’ and ‘in contrast’ which are used in academic writing. Reiteration helps in creating texture because it ensures that our writing is not redundant (Hoey, 1991). Reiteration is an important cohesive tie that includes repetition, synonyms and lexical sets.

Written discourse requires knowledge of certain skills. These are skills of sentence construction, application of linguistic patterns, and rules for sound-symbol relationships (Ivanic, 2004). This approach to written discourse emphasises the correct usage and adherence to conventions for the formal features of academic writing. These rules also apply to writing scientific reports where a set of rules need to be applied, such as reporting in third person or passively.

Written language tends to have less patterns of question formation than spoken language (Martinkova, 2013). There are more restrictions in written discourse; an example would be that of scientific writing which tends to contain more nominalisations such as “the execution of the experiment,” rather than “we executed the experiment”, ‘genetic inheritance’ rather than ‘genes are inherited from parents’. Nominalisations tend to express processes as things (Chodchoey, 1988). Another example would be that of applying for a job where a lot of cultural norms need to be considered. The expression of emotion and attitude is also different in written discourse compared to spoken discourse, as it has to rely heavily on lexicogrammatical descriptions, punctuation, and special fonts and so on. A writer though has the advantage, over a speaker, of reviewing, revising, or otherwise ‘polishing’ their output (ibid).

If the writer is a second language learner, then the conventions of writing will pose a challenge (Martincova, 2013). The language learner has to know how to use genres of discourse in cultural context. Thus, an effective strategy for language learning is to become familiar with the genres of discourse, their conventional structure, and the norms for how and by whom they are used in the context of the surrounding community (Martincova, 2013).

Another aspect of written discourse is that it is a purpose-driven form of communication in social and cultural contexts (Ivanic, 2004). This implies that written communication is a form of social interaction in which meaning is bound in context. The social aspect introduces power into the subject of written communication (ibid). The political status of the community for which written discourse is intended needs to be considered; otherwise misunderstandings may arise. Written text should not just concentrate only on text composition and construction, but also by whom, how, when, where, at what speed, in what conditions, with what media and for what purposes texts are 'written' (Ivanic, 2004).

The issue of power in written discourse is very important as it addresses the social forces involved. Writing has consequences for the identity of the writer (Ivanic, 1998). A writer is therefore guided by the decisions of those in power in terms of what to write, when and how. The tendency would be for the writer to draw on resources that favour those social groups that are more powerful in that context. Hence, writers are not entirely free to choose how to represent the world, how to represent themselves, and how to address their readers when they write. But all these are to some extent determined by the socio-political context in which the writers are writing (Ivanic, 2004).

2.4 The language of science

The scientific language or jargon is the language used in communicating science concepts (Singteach, 2014). This language tends to be too complex for students to understand. Students are reported not to be confused by the complexity of science concepts but by the way the science concepts are communicated (Singteach, 2014 & Yong, 2009). This specialised language of science makes science appear impersonal and even inhuman to many students; thus alienating them.

The main challenge of bilingual students is that of comparing and contrasting two languages in a semantic, cultural and social sense during science lessons. Interference between the two languages might be another problem as understanding in one language interferes with understanding in the other (Jappinen, 2005). Interference exists even between everyday English and the scientific language, between SiSwati and the scientific language, as well as between SiSwati and English. The use of a second language as a medium of instruction at school, especially a colonial language, stresses students and teachers if they are not able to communicate freely in it (Ngwaru, 2011). This has negative consequences for learning such as lack of self-confidence, disaffection and alienation. Practices in these classrooms are dominated by routines, choral responses and code switching (ibid). The natural science teacher has the task of assisting the science students learn with understanding as they switch from one language to the other. All these language responsibilities laid upon the science teacher demand a conducive learning atmosphere – motivated teacher and students (ibid).

2.5 Motivation

Investing in motivation at school is very important since motivation initiates, sustains and directs thinking and behaviour (Weiner, 1992). These days motivation viewed as a precursor to academic achievement is gaining so much interest among psychologists and researchers (Yong 2009). Motivation makes us actively seek or move towards specific kinds of experience (Louw & Edwards, 2010). Sincero (2012) defines it as a state or process in the mind that stimulates, promotes and controls action towards a goal. Then emotions shape our experiences. Motivation and emotions are so intertwined in our daily lives that they form inseparable parts of our daily experiences. Motivation is defined by Brennen (2012) as the level of effort an individual is willing to put towards the achievement of a certain goal. Another definition given by Biehler and Snowman (1993) is that motivation refers to the forces that account for the arousal, selection, direction and continuation of behaviour. Therefore, a student's motivation is the student's desire to participate in the learning process. The desire may be intrinsic, extrinsic or both.

An intrinsically motivated student does an activity "for its own sake, for the enjoyment it provides, the learning it permits, or the feelings of accomplishment it evokes" (Lepper, 1988). On the other hand an extrinsically motivated student performs "in order to obtain some reward or avoid some punishment external to the activity itself". A motivated student is characterised by long-term and quality involvement in learning, as well as commitment to the process of learning (Lumsden, 1994).

Science teachers can use four approaches to motivate their students during class time:

(1) The behavioural view, (2) the cognitive view, (3) the humanistic view, and (4) the achievement motivation theory (Brennen, 2012). These four motivation approaches help teachers in their endeavour to provide the right conditions for student learning – the main purpose of the motivational method used during data collection.

2.5.1 The Behavioural View

The behavioural view focuses on the reinforcement of desired behaviour through the use of extrinsic reward. It explains why some students prefer certain subjects over others. Its proponents were people like BF Skinner and Albert Bandura. It explains motivation in the form of students' identification with someone and also their imitation of someone, resulting in positive academic outcomes. Extrinsic motivation needs to be used with caution though; not excessively. It has to be used only when correct or desired responses occur (Brennen, 2012). For this study the criticism that behavioural motivation causes learners to focus on reinforcers instead of learning, did not apply since gaining the marks (which were reinforcers) was a learning achievement. Another reason was that the award of the reinforcers (marks) was based on quality of student contribution to learning.

2.5.2 The Cognitive View

Cognition refers to the way the mind obtains knowledge and relates thought processes and perception (Sincero, 2012). Therefore, cognitive motivation refers to the stimulation of the mind to result in certain actions for accomplishment of a certain goal. Cognitive theories of motivation tend to focus on learners' beliefs, expectations and needs for order and understanding. Motivation depends on the need people feel they have to succeed and the value they place on success. Their self-efficacy also helps them persevere despite challenges. Setting learning-focused goals also assists learners by sustaining motivation, thus achieving higher goals (Brennen, 2012).

Two cognitive theories of motivation were applied in this study: expectancy theory and goal-setting theory. The expectancy theory was proposed by Vroom in 1964 (ibid) and states that a person will choose certain behaviour over another with the aim of achieving a certain goal. For this study it was hoped that those students who were learning passively would be motivated by the active ones to learn actively and achieve even better scores in their subjects. The goal-setting theory on the other hand states the importance of setting goals in the motivation of a person. It was proposed by Locke in the 1960s. It states that goal setting has some influence on task performance. Students are expected to set specific and challenging goals for themselves. Their goals must be specific, measurable, attainable, realistic and time-bound (SMART). The goals make the students strive for better performance (Brennen, 2012).

The cognitive view of motivation explains the motivation of students to learn in terms of the creation of a cognitive disequilibrium. This is in line with Piaget's concepts of organisation, adaptation and schemata. It works on the view that when people experience a discrepancy between what they know and something new, a state of disequilibrium is created within them which drives them to restore equilibration (Brennen, 2012). Students are driven into disequilibrium by posing questions which will cause them to realise gaps in their thinking, which they shall want to fill (ibid).

2.5.3 The Humanistic View

Humanists start from the assumption that every person has their own unique way of perceiving and understanding the world and that the things they do only make sense in this light (Sammons, 2017). They believe that people have free will and are capable of choosing their own actions. Humanists believe a person has the capacity to make positive and constructive conscious choices. The humanistic view was first proposed by Abraham

Maslow. Maslow advanced that we are motivated by our personal needs to address certain natural concerns. He ordered the needs into five levels (Brennen, 2012):

1. physiological,
2. safety,
3. belongingness,
4. esteem, and
5. self-actualisation.

These 5 levels of needs are often portrayed in the shape of a pyramid (Figure 1) with the largest and most fundamental levels of needs at the bottom, and the need for self-actualisation at the top (Kvalsund, 2003):

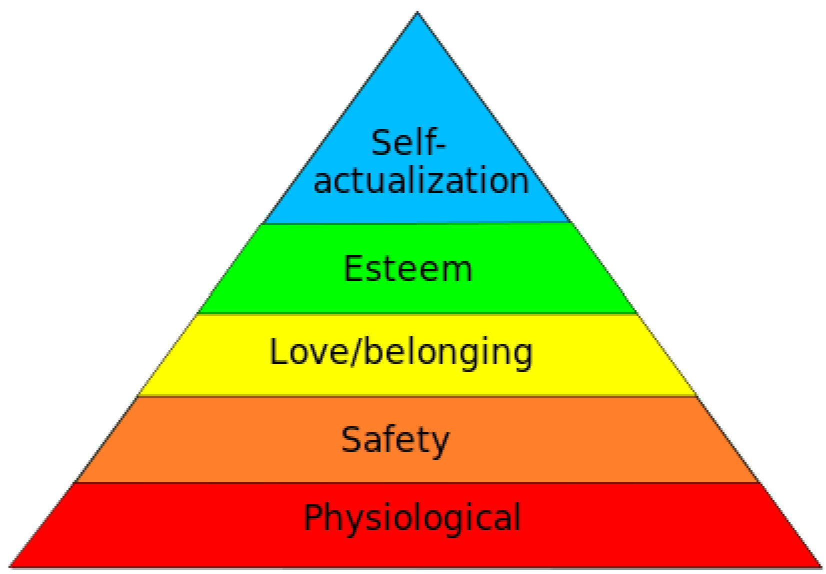


Figure 1, Maslow's hierarchy of needs, represented as a pyramid with the more basic needs at the bottom, based on Ragnvald Kvalsund, 2003.

although recent research challenges the hierarchy of human needs proposed by Maslow, it also validates the existence of universal human needs (Villarica, 2011; Tay & Diener, 2011). What is more, studies have found little evidence for the ranking of human needs by Maslow or for the existence of a definite hierarchy (Wahba & Bridwell, 1976). In essence, the research found that Maslow's hierarchy of human needs is not universal because it has been found to vary across cultures due to individual differences and the availability of resources in a respective country or geopolitical entity (Tang et al., 2002). Nevertheless, Maslow's theory has remained influential because: (a) it is doubtful whether or not Maslow intended the theory to be applied rigidly: (b) it is true that the lowest needs are particularly pressing and, as one pressing need becomes satisfied, other needs that were ignored come to the fore; and (c) Maslow emphasised the importance of satisfying the whole range of human motivations for a satisfying life by considering the balanced needs of being (Louw & Edwards, 2010). Said needs include justice, simplicity, playfulness, and meaningfulness.

These five basic human needs are not met in isolation, but rather with the help of cognitive and aesthetic needs. Maslow maintained that the freedom to investigate and learn as well as fairness, honesty, and orderliness in interpersonal relationships makes realisation of the five basic human needs possible (Brennen, 2012). Therefore, teachers have the task of enhancing the self-esteem of their students by creating classroom conditions - such as the motivational method used in this study - that increase students' achievement.

What follows is a discussion of the five basic human needs as described by Maslow (Louw & Edwards, 2010; Maslow, 1943).

2.5.3.1 Physiological Needs

Physiological needs are considered the most important and should be met first because they include air, water, food, shelter, sleep and sex. These are bodily requirements that must be met otherwise the body cannot thrive and will ultimately fail. The first are metabolic requirements for survival in animals while clothing and shelter are for protection. Maintained birth rates control sexual competition. These needs are for the immediate survival and comfort of the human body, which is why Maslow referred to them as “deficiency needs” because the absence of such needs will, for example, affect a student adversely at school (Louw & Edwards, 2010; Maslow, 1943).

2.5.3.2 Safety Needs

Safety needs are necessary for long-term survival and comfort. They dominate human behaviour after physical needs are at least relatively met. The absence of safety needs may result in people (re)experiencing post-traumatic stress due to circumstances and events such as war, natural disasters, family violence, and childhood abuse. Safety and security needs include order, stability, employment, home-owning, income/savings, and health. Absence of these affects children as they have a greater need to feel safe at all times. The absence of economic safety manifests itself in the form of preference for job security, savings accounts, insurance policies, and disability accommodations. For instance, students begin underperforming once their safety is under threat, which is also the case for most human beings (Louw & Edwards, 2010; Maslow, 1943).

2.5.3.3 Love and Belonging Needs

The third level of human needs - according to Maslow, of course - is the interpersonal, which is strong in childhood because it involves feelings of belongingness. Belongingness overrides safety in childhood and is witnessed in children who cling to abusive parents. The average child desires to obtain unconditional love and acceptance from his or her significant others (Sincero, 2012b). Affiliation and acceptance mark this level, so their deficiencies impact the individual’s ability to maintain emotionally significant relationships such as family, friendship, and intimacy. However, today’s society seems to dictate that a child will only receive love and care if he or she meets the expectations – quiet, well-mannered, obedient - of the significant other(s). Because of this, Carl Ransom Rogers theorised that these external conditions give an increasing level of influence to a person’s behaviour. When one’s behaviour and actions are continually reinforced by such conditions, one develops the personality type that corresponds to one’s behaviour (ibid).

Maslow says it is natural for humans to feel a sense of belonging and acceptance amongst their social groups (i.e., clubs, co-workers, sports teams, mentors or intimate partners). People need to love and be loved in order to prevent susceptibility to conditions such as loneliness, social anxiety, or clinical depression. Obviously, a student deprived of needs pertaining to love and belonging will be demotivated and may even drop-out of school. Some youths may even go to the extent of ending their lives or taking the lives of others (Louw & Edwards, 2010; Maslow, 1943).

2.5.3.4 Esteem Needs

It is natural for human beings to feel the need to be respected, and esteem presents the human desire to be accepted and valued by others. Humans often engage in an activity or an endeavour to gain recognition because such activities provide the person with a sense of contribution or value. Imbalances in esteem may result in low self-esteem or inferiority complex. People with a low self-esteem covet respect from others – however, in order to build their self-esteem they must begin by internally accepting themselves. Psychological imbalances such as depression can hinder a person from obtaining a higher level of self-esteem or self-respect. A student with a low self-esteem or a low sense of self-respect will lack self-confidence and, thus, also lack competence and mastery and freedom. Therefore, deprivation of esteem needs can ultimately lead to inferiority complex, weakness, and helplessness (Louw & Edwards 2010; Maslow 1943).

2.5.3.5 Self-actualisation Needs

In his theory, Rogers stated that the organism has one basic goal: self-actualisation (Sincero, 2012b). According to Rogers, we exist because we need to gratify this need of self-actualisation. The Humanistic view believes that each individual has within himself or herself a nature as well as a potential that he or she can actualise. Self-actualisation is about accomplishing everything within one's ability in order to fulfil or satisfy one's perceived sense of potential. This level refers to what a person's full potential is and the realisation of that full potential. Understanding this level demands mastery of the previous needs. Some people perceive this need by having a strong desire they express through things such as parenting, painting or inventing. Self-actualisation is about expressing life fully and developing one's unique values and capacities. This need has to be instilled early in pupils ensure it becomes their ultimate dream in adulthood (Louw & Edwards, 2010; Maslow, 1943).

Rogers contributes positively to education from the humanistic view (Corey, 2009). In essence, Rogers' theory emphasises that the chief indicator that we shall reach self-actualisation is our experiences during childhood (Sincero, 2012b) – that is, every child must obtain unconditional love and acceptance from his or her significant other(s). Rogers applied his person-centred approach to many fields - including education – because he believed that, in order for a student to learn freely, the teacher/facilitator should possess three basic attributes: (1) genuineness (congruence), (2) acceptance and caring (unconditional positive regard), and (3) empathic understanding. The strength of Rogers' approach to education relies on the type of personal relationship between the teacher/facilitator and the learner (Corey, 2009). Rogers claimed that a person cannot be taught directly, but rather his or her learning can only be facilitated. The facilitator of learning should therefore possess or display the aforesaid three attributes.

An effective facilitator is one who communicates with the learner on a person-to-person basis, without presenting a facade – in essence, - genuineness. Rogers defined congruence as the facilitator's ability to be genuine and – integrated as well as freely and deeply one's self within the teaching/learning relationship. Genuineness has to be expressed with intentionality, therapeutic purpose, and self-discipline (Greenberg & Geller, 2001) because a congruent individual is honest, direct, and sincere in what they convey (Ray, Stulmaker & Jayne, 2014). As such incongruence is demonstrated through inconsistencies between what facilitators say and what they imply through gestures, expressions, or their tone of voice as well as through indications of anxiety, discomfort, or tension. Congruence is demonstrated when the facilitator is an integrated person who is open and available to connect with the learner, which includes also being genuinely empathic and accepting toward the learner (Cochran, Nordling, & Cochran, 2010).

Therefore, genuineness is considered to be the channel by which empathy and acceptance are conveyed (Ray et al., 2014). It is the duty of the teacher to create a climate of facilitative attitudes from which the learner can begin to develop the capacity for self-understanding as well as the capability to alter his or her self-concept and self-defeating behaviours (Thorne, 1990).

A successful facilitator of learning also has trust and confidence in the learner. With unconditional positive regard the facilitator should accept the learner as a trustworthy individual with whom there may exist imperfections, feelings, and potentialities (Corey, 2009). A facilitator/teacher should seek to offer the learner unconditional acceptance, a positive regard (or caring), and a non-possessive love (Thorne, 1990). Therefore, the facilitator should neither be frightened nor threatened when confronted by a learner who possesses values, attitudes, and feelings different from his or her own. Genuine acceptance is unaffected by background differences or by the belief system between facilitator and student, for it is in no way dependent on moral, ethical, or social criteria.

The third attribute to be possessed by facilitators is empathic understanding. A teacher should have the ability to see the process of education from the student's point of view and, thus, understand the student's reactions. Rogers claims that students learn best in an atmosphere where they are neither evaluated nor judged, but rather understood from their own point of view instead of the teacher's – in other words - empathic understanding (Corey, 2009). Empathic understanding demands a high degree of sensitivity toward the experiences of the learner so that the teacher is recognised as a reliable companion (Thorn, 1990). To meet the demands of empathic understanding, a teacher must put aside all his or her prejudices and values because the teacher is required to be secure in his or her own identity in order to be capable of moving into another's world (ibid). A facilitative climate where genuineness, acceptance, and empathy are all present will aid a student in changing his or her self concept via self-understanding. Therefore, the three qualities are essential when a facilitator desires to work with a learner as a whole.

As Rogers theorized, Maslow believed that one's ultimate goal in life is self-actualisation. Some characteristics of a self-actualised individual are (Sincero, 2012b):

- Autonomous and independent
- accurate perceptions of reality
- able to accept oneself, others, and society
- feeling as one with nature
- Democratic and appreciative

It is human nature to aim for these positive characteristics.

2.5.4 The Achievement Motivation Theory

Achievement motivation is an attitude of competitiveness as well as willingness to overcome obstacles and accomplish difficult tasks (McCown et al., 1996). This means achievement is a product of the amount of risk-taking behaviour and of the types of goals (ibid), so achievement motivation is therefore a stable trait resulting from the home environment and how parents raise their children (McCown et al., 1996). It is a natural human desire to achieve intrinsic satisfaction for one's success (Louw & Edwards, 2010), and children with a high need to achieve tend to pursue goals that are challenging and realistic.

The achievement motivation theory rests on the belief that most people want to achieve and experience levels of aspiration (Brennen, 2012). That is people want to succeed at the highest possible level whilst avoiding failure because the need to achieve increases when success is experienced. This is true even for students because as they experience success, their need for achievement is strengthened. However, some females in certain situations fear success when it interferes with relationships (ibid). Psychologists have developed the Attribution Theory to explain the factors that students attribute to failure. In essence, low achievers tend to attribute lack of ability to failure and sheer luck to success while high achievers attribute lack of effort to failure and effort/ability to success (ibid).

Adolescents usually employ peer relationships as an important source of support and companionship for social development. The teacher can establish conducive preconditions to their students' learning: (a) providing a supportive environment, (b) establishing what students already know before teaching them new content or skills, (c) allowing students sufficient time for thinking as well as sufficient time to practise a skill, (d) breaking down tasks into manageable units, (e) assigning tasks with the appropriate level of difficulty, and (f) giving frequent informative feedback (Brennen, 2012).

2.6 Teaching and learning

Teaching and learning occur almost simultaneously. Teaching tends to happen first, then learning. Sometimes we learn from experience. There are theories to explain this process; the ones that shaped this study viewed the learning process conditioning (classical and operant), social dimension (social learning theory), as well as cognitive (Louw & Edwards, 2010). Psychologists define learning as a relatively permanent change in behaviour or knowledge as a result of experience, which means new ways of thinking and behaving can be learned (ibid.). This is the definition adopted for this research. But learning can occur without obvious changes in behaviour. The use of "relatively" in the definition allows for variations since what has been learned can be unlearned when necessary.

2.6.1 Conditioning

Conditioning means bringing behaviour under the control of the environment (McCown et al., 1996). Conditioned learning is a form of associative learning (J.L., 2014). For instance, in a school setting, we expect student behaviour to be in line with the school environment, for effective learning to take place (ibid).

This section discusses two basic types of conditioning: classical and operant.

2.6.1.1 Classical conditioning

Classical conditioning is how we learn to adapt to our environment in a practical way (Louw & Edwards, 2010). It is a reflexive or automatic type of learning in which a stimulus that used to evoke a response is replaced by another stimulus (Pavlov, 2003).
Ivan Pavlov discovered classical conditioning in 1904, after his famous experiment on dog salivation. Pavlov identified six conditioning processes: reinforcement, response acquisition, extinction, spontaneous recovery, generalisation and discrimination (ibid). John Watson applied Pavlov's discovery to human beings and called it behaviourism (Watson, 2013).

In a school environment all activities are programmed and then regulated by an electric bell. When it rings the bell stimulates teachers and students to get ready for a different activity, be it a chemistry lesson, lunch, assembly or sports. This is how classical conditioning works to make teachers and students learn to adapt to the school environment.

2.6.1.1.1 Reinforcement

Reinforcement is the intentional presentation or natural occurrence of the unconditioned stimulus, or UCS, combined with the conditioned stimulus, or CS (Louw & Edwards, 2010). In the classroom situation the unconditioned stimulus is the subject teacher and the conditioned stimulus is the electric bell. Seeing the chemistry teacher walk into the classroom or laboratory at the beginning of a chemistry class increases students' readiness to learn chemistry. This association motivates students to learn and instils in them a culture of learning (ibid). The hope is that reinforcing this culture of learning will increase student engagement during science lessons.

2.6.1.1.2 Response acquisition

Reinforcement is the basis for response acquisition (Louw & Edwards, 2010). In order to help students learn different subjects, the bell needs to ring regularly and reliably, and teachers need to turn up shortly after the bell. This is especially important when students are back from a long break such as the Christmas holidays.

2.6.1.1.3 Extinction

Extinction refers to the state where an organism will stop exhibiting the conditioned response because the conditioned and unconditioned stimuli have not been paired for a given number of trials (Hall, 1998). For instance, students lose their motivation to learn when a teacher fails to arrive promptly after the bell a few days in a row (Louw & Edwards, 2010).

2.6.1.1.4 Spontaneous recovery

Spontaneous recovery is the re-occurrence of a classically conditioned response after extinction has occurred (Hall, 1998). If a teacher appears when the bell rings after two days of not doing so, the students' readiness to learn will return (Louw & Edwards, 2010). The same process occurs when a student returns to school after a significant absence due to illness or other reason. While the student is away from school his motivation to learn might go extinct, but hearing the bell ring upon his return to school will immediately bring it back. Spontaneous recovery is the reason why weekends and holidays do not disrupt the learning culture of the school.

2.6.1.1.5 Generalisation

Generalisation refers to an instance where a conditioned response generalises to a new but similar stimulus (Louw & Edwards, 2010). This happens when new stimuli that are like the conditioned stimulus come to elicit the same response (Hall, 1998). Such as the use of a hand bell instead of the usual electric one to regulate activities during a power outage. Students and teachers respond positively to this new bell, even though it is less loud than the regular one.

By contrast, students' willingness to engage in discussions during science lessons did not spread out to other subjects. This may be explained by the difficulty to control for what teachers do in their classrooms (Jita & Mokhele, 2013).

2.6.1.1.6 Discrimination

Discrimination is the opposite of generalisation. It occurs when a trained organism responds only to the original conditioned stimulus and not to a similar one (Louw & Edwards, 2010). At the school where the research was conducted students had been taught to respond differently to the bell depending on how many times it was rung. Once indicated a normal change of periods. Twice meant they had to stop whatever they were doing and leave school at once for home. If it rang thrice they had to stop whatever they were doing and rush to assembly point.

Discrimination is useful during sports to avoid confusion between various whistle tones. It also plays an important role in the classroom where students are expected to understand the meanings of ordinary words when used technically in subjects like the natural sciences. Being able to discriminate between various tones of voice is also important during interactions since various messages are sent to the other person(s) that way (Louw & Edwards, 2010).

2.6.1.2 Operant conditioning

Operant conditioning is different from classical conditioning in that it involves voluntary behaviour patterns instead of involuntary ones (Louw & Edwards, 2010). In operant conditioning a response occurs before a reinforcing stimulus. This was the tool used to increase students' willingness to engage in classroom discourse during natural science lessons. Operant conditioning involves manipulating our environment. We describe the process with terms similar to those used to describe classical conditioning, but some, such as reinforcement, extinction, generalisation and discrimination, mean something different. Following are brief descriptions of the terms used in operant conditioning (ibid).

2.6.1.2.1 Shaping

Shaping is the reinforcement of successive approximations of the desired response intended to be conditioned. It continues until the required response begins to occur. Once the required response starts happening reinforcement only occurs after the required response (Louw & Edwards, 2010). During a science lesson the teacher can shape students by praising them when they attempt to use proper scientific terms orally or in writing. Praising may continue until students fully understand the terms and use them correctly. Shaping was among the techniques observed during data collection.

2.6.1.2.2 Extinction

Extinction occurs when a contingency relationship between a response and reinforcement is undone (Louw & Edwards, 2010). With human beings extinction results in the eradication of bad behaviour. During data collection the researcher observed how the science teacher discouraged behaviour that impeded classroom discussions to the point of extinction. The eradicated behaviours included laughing at another student who attempted to answer, asking a question at an important time, or copying another student's work instead of asking for an explanation.

2.6.1.2.3 Spontaneous recovery

Spontaneous recovery is the recovery of an extinguished response after a rest interval (Louw & Edwards, 2010). The response need not be learnt again, it resumes spontaneously. At school this could mean a smooth return to studying or doing homework after a long vacation such as the Christmas holidays.

2.6.1.2.4 Generalisation

Reinforced responses conditioned to follow specific stimuli can also occur following similar stimuli, but not always. The researcher had hoped the improvement in classroom discourse among science students would be generalised to other subjects but in fact students had to be motivated in most school subjects, especially core ones (Louw & Edwards, 2010).

2.6.1.2.5 Discrimination

Only responses which follow appropriate stimuli are reinforced, a process known as differential reinforcement. If a different stimulus is paired with the unconditioned stimulus, that new stimulus is called a discriminative stimulus (Louw & Edwards, 2010). Being good at interpreting subtle discriminative stimuli makes it easy to understand and interpret facial expressions and body language during social interactions.

2.6.1.2.6 Reinforcement

Reinforcement increases the probability that a particular behaviour will be repeated. That is the principle of contingency. To be effective reinforcement must occur immediately after the required response (Louw & Edwards, 2010). Reinforcement is crucial to operant conditioning, as was demonstrated in this study where a student was awarded points for effective classroom engagement.

Reinforcers can be primary or secondary. A primary reinforcer has a survival function and serves a basic need, whereas a secondary reinforcer has no reward value and is learned as well as associated with other reinforcers. Reinforcement can be positive or negative. It is positive when the required response increases as a result of a pleasant stimulus and negative when the required response occurs with the removal of an unpleasant stimulus. The patterns of giving reinforcement are called schedules of reinforcement. This can happen continuously or intermittently. Reinforcement is continuous if it is awarded immediately the desired behaviour is shown, and intermittent when given once in a while (ibid.).

2.6.2 Cognitive learning

Cognition is the process of acquiring and understanding knowledge through our thoughts, experiences, and senses (Sincero, 2012a). Sincero (2012a) also defines learning as the acquisition of knowledge through experience, study, or being taught. Cognition and learning are similar in that learning requires cognition and cognition involves learning. Cognitive learning occurs as a result of changes in our thoughts, ideas, beliefs, understanding and knowledge (Louw & Edwards, 2010). During cognitive learning data is ingested and processed into information. However, this may not necessarily result in different observable behaviour.

Cognitive psychologists claim thought processes or mental activities occur during the conditioning process. That is why humans, as well as animals, can anticipate future events and thus adjust their behaviour to get what they want. This anticipation of future events (a cognitive process) is the root of all learning processes. The cognitive perspective of learning illuminates an important aspect of reinforcement through reward. It warns that rewarding a behaviour which is already enjoyed can undermine the satisfaction the person feels when simply engaging in that behaviour (ibid).

Insight is another form of cognitive learning. Insight is the sudden, spontaneous and total clarification, often following several unsuccessful trial-and-error attempts. The cortex of our brains is so well developed that it enables us to solve much more complex problems through insight. This deeper understanding is very important for learning complex and abstract concepts in the sciences, and particularly for inventions and discoveries (Louw & Edwards, 2010). Among students, reinforcers help arouse latent learning which is learning not yet reflected in behaviour. To master our environment, we also form cognitive maps which are also important for learning purposes in the classroom (ibid), as they enable us to perform new responses to reach a goal in case the usual way is not possible.

2.6.3 Social learning

Social learning occurs through social interaction. One way social learning takes place is through observational learning in which we consciously observe others and then imitate them. In this form of learning, college and university students learn by observing and imitating others (Louw & Edwards, 2010). Social learning theorists oppose the idea that all or most human learning processes are based on classical or operant conditioning or on isolated cognitive processes (ibid). They explain human behaviour in terms of continuous reciprocal interaction between cognitive, behavioural, and environmental influences (Cullata, 2015).

2.6.3.1 Social learning theory

In the early 1960s, Albert Bandura ushered in the social learning theory (Louw & Edwards, 2010). This theory explains how we learn from the mistakes of others, rather than solely through our own experiences. The social learning theory of Bandura emphasises the importance of observing and modelling the behaviours, attitudes, and emotional reactions of others (Cullata, 2015). The main principles of social learning theory are:

- People learn by observing others.
- Learning is an internal process that may or may not change behaviour.
- People behave in certain ways to reach goals.
- Behaviour is self-directed (as opposed to the behaviourist thought that it’s determined by environment.).
- Reinforcement and punishment have unpredictable and indirect effects on both.
- Behaviour and learning (Cullata, 2015).

The social learning theory integrates cognitive and conditioning principles while emphasising social interactions as key to learning. For this reason, the theory was one of the guiding principles for the study as social interactions are the focal point, and the research places value on those interactions.

Bandura identified four elements that mark the social learning process: (a) attention to and observation of other's relevant behaviour; (b) memories of the behaviour in words, and / or visual images; (c) translation of the behaviour from memory to action; and (d) motivation to carry out the observed behaviour (Louw & Edwards, 2010). The four elements of the social learning theory have all incorporated cognitive processes. Modelling is one form of observational learning in which a person learns to reproduce or copy behaviour exhibited by a model (Louw & Edwards, 2010). The highest level of observational learning is achieved by first organising and rehearsing the modelled behaviour symbolically and then enacting it (Cullata, 2015). Simply observing behaviour is less effective than coding the observed behaviour into words, labels or images (ibid).

The social learning theory teaches that antisocial models such as those engaged in criminal or violent behaviour in children's environments, can lead to developing antisocial behaviour (Louw & Edwards, 2010). This theory also teaches that reinforcement and punishment of children and their models determines whether people will carry out behaviour they have observed (Louw & Edwards, 2010). The theory is applied extensively to the understanding of aggression and psychological disorders (Cullata, 2015).

When used together with operant and cognitive principles the social learning theory yields the self-control paradigm, in which self-control refers to the changes in behaviour that are relatively independent of external forces (Bandura, 1986). Self-control is important in bringing about behaviour change and Bandura realised that self-regulated behaviour was central to learning. During lesson time, the students are thus encouraged to interact effectively with colleagues, their teachers and with the subject content. It is particularly important among today's students, as contemporary education systems advocate for learner-centred curricula in most countries. Students need to learn self-control from their teachers, who are their models. Self-regulated behaviour is marked by aspects such as self-observation, self-assessment and self-reinforcement (ibid).

Through self-observation students monitor their own progress through self-assessment (Bandura, 1986), which helps them evaluate their goals and behaviour. Teachers only need to teach students self-regulation so that they are self-driven. Self-reinforcement assists students to accomplish their academic goals with positivity when they do, and negativity when they do not.

Observational learning is a very important skill to be mastered by every Natural Science student in particular, as observation is one of the science process skills that Natural Science students are expected to know and apply.

2.6.3.2 Social constructivism

Social learning is described by social constructivists as a way of cultural apprenticeship in which novice members of a culture learn from their tutors (Osborne, 1996). The novice members are introduced to a community of knowledge through discourse. In this research, the novice members were the Natural Science students, and the tutors were the Chemistry and Physics teachers. In constructivism, learners are taught to question, challenge, and critically analyse information rather than blindly accept what is taught. Social constructivism is a learning approach that resulted from three learning theories: those of Lev Vygotsky, David Ausubel and Jean Piaget (Cakir, 2008). These three cognitive theorists have been highly influential in understanding the process of human learning.

For Piaget, people use mental patterns (schemes) to guide behaviour and cognition, and interpret new experiences and material in relation to existing schemes. However, for new material to be assimilated, it must first fit an existing scheme. Piaget’s theory is stage dependent. Children as learners progress through four distinct stages of cognitive development, and are able to grasp concepts at increasing levels of abstraction depending on their level of maturity (Slavin, 1988). Similarly, for Ausubel, meaningful information is stored in networks of connected facts or concepts referred to as schemata. New information, which fits into an existing schema, is more easily understood, learned, and retained than information that does not fit into an existing schema. For both theorists new concepts that are well attached to existing schemata (or schemes) are more readily learned and assimilated than new information relating to less established schemata. The same holds true for information not attached to any schemata at all; for example rote learning, which Ausubel (1963) defines as 'arbitrary, verbatim, non-substantive incorporation of new ideas into cognitive structure'.

For Vygotsky language is central to the development of thought; and words are the means through which thought is formed. The importance of language is in concept development. A concept is not fully realised or understood until it is represented in words (Cakir, 2008). According to Vygotsky students construct their own understanding with guidance from a more capable peer. They can be said to be learning within the zone of proximal development, which is the gap between what a learner has already mastered (the actual level of development) and what he or she can achieve when provided with educational support (http://www.learnnc.org/lp/pages/5075). According to the Vygotskian concept of zone of proximal development, social interaction is the basis for cognitive growth. Accordingly, the communication that transpires in a social setting with more knowledgeable or proficient people (parents, teachers, peers, others) assists students in building an understanding of the concept.

Social constructivists describe knowledge acquisition as personal and social, with communication playing a pivotal role. They stress on understanding as the main goal of science instruction (Matthews, 1993). It was for the concepts of communication and understanding that social constructivism was chosen as an appropriate theory for this research. Yeany (1991) noted that there are two sources of knowledge for a student. First is the knowledge that a student acquires from interaction with the environment, and the second is through formal instruction or disciplined learning in school. The former is called intuitive or 'gut' knowledge and its primary characteristic is that it constitutes the student's reality. The primary characteristic of the latter's source of knowledge is based on authority and is goal directed.

The construction of knowledge by students, especially everyday knowledge, has the challenge of misconceptions. Students spend considerable time and energy constructing their naive theories, and they have emotional and intellectual attachments to them, finding it difficult to replace them with scientific theories. A critical point is that it is only when the learner, rather than the teacher, decides, implicitly or explicitly, that the conditions have been met that conceptual change occurs. The conditions for conceptual change are as follows: Is the concept meaningful to the learner? Is the concept truthful to the learner? Is the concept useful for the learner? (Hewson & Thorley, 1989). The more conditions that a concept meets the higher its status is, so the status of a person's conception is the extent to which the conception meets these three conditions. If the new conception conflicts with an existing conception it cannot be accepted until the status of the existing conception is lowered. This only happens if the learner holding the conception has reason to be dissatisfied with it.

Changes in the knowledge state of a student occur by assimilations, accommodations, and disequilibrations (Posner, Strike, Hewson, & Gertzog, 1982). These three terms are useful for describing conceptual change. Assimilation occurs when an event fits an existing conception. This process is selective and ignores discrepancies deemed not important, as it strengthens existing beliefs and convictions.

Accommodation is a change in a conception about how the world works. This change enables an event to be assimilated that could not have been under previously held conceptions. Accommodation can be viewed as a competition between conceptions. It occurs when a student becomes motivated to change by entering a state of cognitive disequilibration, which occurs when new experiences do not fit into an existing scheme (McCown et al., 1996).Disequilibration is the surprise produced when an expected event does not occur (Posner et al., 1982) and is the main cause of conceptual change.

Dissatisfaction with the present conception decreases its status, while exploring the fruitfulness of an alternative conception increases the alternative's status. Whenever the alternative's status exceeds the present conception's status, accommodation will move forward. In this process, scientific, as well as everyday concepts are not taken in all at once in completed form, but rather develop over time. There is movement back and forth in the student's mind between everyday and scientific concepts until they come together into a system, which is very important for networking of the concepts in the student's brain. Should the incorporation of new ideas into cognitive structure be without specific relevance to existing concept or propositional frameworks, then the result is rote learning.

It is essential for a teacher to create a classroom environment in which students are free to suggest tentative ideas and then to test them without concern for the rightness or wrongness of these ideas, as it's in the heat of debate that progress is made when each side attempts to understand the other's position well enough to find discrepancies in their argument. The teacher should come in to clarify certain things in case of confusion or disagreements. Such learning is socio-cultural and empowers students to maintain cultural integrity, while succeeding academically (Coffey, 2008). The cultural part of learning is very important since culture determines how we think, believe, and behave (ibid). Culture is a student's beliefs, motivations, and even social groups and norms. Thus, the teacher who practices culturally relevant teaching understands that culture manifests in a variety of adaptations within how students prefer to learn. A culturally responsive teacher uses differentiated instruction to tailor learning to a student's culture.

Social constructivism describes human development as proceeding interactively from the social to the individual (Stears & Malcolm, 2005). Learning too is explained as occurring within the context of social interactions, and classrooms that are characterised by socio-cultural learning have students that are able to articulate their ideas, as their teachers support and scaffold their discourse (Langman & Fies, 2010). Social constructivism stresses student engagement in learning through dialogue, conversation and argument in a social setting (Matthews, 1993). Therefore, natural science students need to be encouraged to engage in discourse (especially verbal) during science lessons for proper knowledge acquisition and understanding of scientific concepts. The base for the students' formal knowledge is laid by their day-to-day social interactions of culture and everyday life (Stears & Malcolm, 2005; Ruiz de Mendoza & Gómez González, 2014), and it is during those interactions with teachers and other more capable peers, that the zone of proximal development or the gap between what they have mastered and what they can achieve when provided with educational support is narrowed.

Natural science students, therefore, need to be encouraged to engage in discourse (especially talking) during science lessons for proper knowledge acquisition and understanding of scientific concepts. The base for the natural science students' formal knowledge is laid by the students' day-to-day social interactions of culture and everyday life (Stears & Malcolm, 2005). During the day-to-day social interactions of students with their teachers and other more capable peers, the gap between what the students have mastered and what they can achieve when provided with educational support is narrowed. This gap is the one Vygotsky (1978) termed the zone of proximal development (ZPD).

The ZPD was described by Vygotsky (1978) as a zone for each student, bounded on one side by the developmental threshold necessary for learning, and on the other side by the upper limit of the student's current ability to learn the material under consideration. Vygotsky contended that the basis for cognitive growth lies within the ZPD social interactions. The communication that transpires in a social setting with more knowledgeable or proficient people (parents, teachers, peers, others) assists children in building an understanding of the concept (Coffey, 2008; Karim, 2010). In a classroom, for instance, the teacher is responsible for structuring social interactions and developing instruction in small steps, based on tasks the students are already capable of performing independently – a practice called scaffolding. The teacher is also charged with providing support until the students can move through all tasks independently. The teacher's instruction should emphasise connections to what the learner already knows in other familiar, everyday contexts (Zeuli, 1986).

The social interactions within the classroom during learning are monitored by the teacher. Teaching methods that encourage social interaction in the classroom include collaborative learning strategies such as peer tutoring and cooperative learning. Collaborative learning advances a student's zone of proximal development because the student is assisted on a task by more capable people. The assistance continues until the student can perform the task independently. The two natural science teachers involved in this study used a variety of collaborative learning strategies to accomplish the learning outcomes. Collaborative learning refers to learning activities where students work together in groups small enough for everyone to participate in a collective task that has been assigned (Smith & MacGregor, 1992). The task can be done jointly (where group members do different aspects of the task but contribute to a common overall outcome) or shared (where group members work together throughout the activity).

Collaborative learning works well when teachers use approaches which promote dialogue and interaction among learners. Collaborative learning approaches such as projects, cooperative learning, discussion, peer instruction and frequent quizzing are documented to have the best gains since they promote dialogue and interaction among students and have higher learning gains than traditional lecture-based teaching (Thompson, 2013). Collaboration can be supported with competition between groups, but teachers should be cautious as this can lead to learners' focusing on the competition rather than the learning (ibid.). The motivational method used in this study to promote discourse during learning incorporated competition.

One of the constructivist strategies in collaborative learning is peer tutoring. Peer tutoring is a system of instruction in which learners help each other to learn by teaching (https://en.wikipedia.org/wiki/Peer tutor). This system of instruction features a tutor and a tutee. A peer tutor is anyone who is of a similar status to the person being tutored. In a school, this is usually a student from the same grade or higher, who may have taken the same or similar classes recently. Peer tutoring is beneficial to both the tutor and the tutee. One reason is that the tutor can establish a rapport with the tutee in a way that a teacher cannot. A second reason is that advice given by the tutor may be accepted more readily than advice from a teacher, since the peer tutor is seen by the tutee as being more at his or her own level. Another reason is that a peer tutor does not give any grade on the paper, whereas a teacher serving in a tutor role may still be perceived as someone who grades papers. The tutor learns not only how to ask useful questions, but also develops social listening skills. Peer tutoring allows for higher rates of student response and feedback, which results in better academic achievement. It also creates more opportunities for students to practise specific skills, which leads to better retention. Students involved in peer tutoring show more positive attitudes toward learning and develop self-confidence.

Commonly used peer tutoring models are (Hott , Walker, Mason, & Sahni, 2012):

1. Class-Wide Peer Tutoring (CWPT);
2. Peer Assisted Learning Strategies (PALS);
3. Same-Age Peer Tutoring;
4. Cross-Age Peer Tutoring; and
5. Reciprocal Peer Tutoring (RPT).

2.6.3.2.1 Class-Wide Peer Tutoring (CWPT)

Class-wide peer tutoring involves dividing the entire class into groups of two to five students with differing ability levels. Student pairings or groups are fluid and may be based on achievement levels or student compatibility. At times, students are grouped to promote social development or opportunities to work with peers from a variety of backgrounds. Student pairings or groups may change weekly or biweekly, and students take turns to act as tutors, tutees, or both tutors and tutees. Typically, CWPT involves highly structured procedures, competitive teams, and posting of scores (Hott et al., 2012). The entire class participates in structured peer tutoring activities two or more times per week for approximately 30 minutes.

2.6.3.2.2 Peer Assisted Learning Strategies (PALS)

This is a version of the CWPT model where the teacher pairs off students who need additional instruction or help with a peer who can assist. Students are typically paired with other students who are at the same skill level, without a big difference in their abilities. The groups are flexible and change often across a variety of subjects or skills. All students can function as a tutor or tutee at different times.

2.6.3.2.3 Same-Age Peer Tutoring

Peers who are within one or two years of age are paired to review key concepts. They may have similar ability levels, or a more advanced student can be paired with a less advanced counterpart. Students who have similar abilities typically have an equal understanding of the content material. When pairing students with differing levels, the roles of tutor and tutee may be alternated, allowing the lower performing student to quiz the higher performing student. Answers should be provided to the lower performing student when such student is acting as a tutor in order to assist with any deficiencies in content knowledge. Same-age peer tutoring, like class-wide peer tutoring, can be completed within the students' classroom or across different classrooms. In this situation, procedures are more flexible than traditional class-wide peer tutoring configurations.

2.6.3.2.4 Cross-Age Peer Tutoring

Older students are paired with younger students to teach or review a skill. The positions of tutor and tutee do not change: the older student serves as the tutor and the younger student as the tutee. The tutor and tutee can have similar or differing skill levels, with the relationship being one of a cooperative or expert interaction. Tutors serve to model appropriate behaviour, ask questions, and encourage better study habits.

2.6.3.2.5 Reciprocal Peer Tutoring (RPT)

In this model, students alternate equally between acting as the tutor and tutee during each session. Often, higher performing students are paired with lower performing students. RPT utilises a structured format that encourages the use of teaching materials, monitoring answers, and evaluating and encouraging peers. Students in RPT may prepare the instructional materials themselves, and are responsible for monitoring and evaluating their peers once they have selected a goal and reward as outlined by their teacher. Both group and individual rewards may be earned to motivate and maximise learning.

2.6.4 Challenges to Learning

Challenges to learning are known to occur among students of all different backgrounds. They impede the progress of the student by deterring the learning process, and can be cognitive, emotional, physical, and even environmental (Louw & Edwards, 2010). Cognitive challenges involve the processing of data in the brain, such as thinking and reasoning (Brown, 2003). High order cognitive skills are needed the most in the sciences, since scientific concepts are mostly abstract (ibid.). Examples of emotional challenges include motivation, courage, endurance and perseverance. Physical challenges include neurological disorders such as nonverbal learning disabilities (NLD), which cause problems with visual-spatial, intuitive, organisational, evaluative and holistic processing functions of the right hemisphere of the brain. Other physical challenges encountered by students include nutrition, health, and writing and learning styles. Environmental challenges include the type of school, size, start and stop times, as well as weather conditions (Louw & Edwards, 2010).

Since the literature reveals lack of motivation as one of the causes of students' engaging poorly in science lessons, the researcher felt other challenges to learning needed mentioning in this study, too. However, the main purpose of this study was to devise a strategy for encouraging students to learn actively during science lessons.

2.6.5 Teaching and Learning Styles

Teaching and learning styles are the behaviours or actions that teachers and students exhibit in the teaching/learning process. Teaching behaviours reflect the beliefs and values that teachers hold about their learners (Brown, 2003). Learners' behaviours provide insight into the ways the learners perceive, interact with, and respond to the environment in which learning occurs. When students' learning preferences match their teachers' teaching styles, their motivation and achievement usually improve (ibid.). Each of us has a specific learning style (sometimes called a "preference"), and we learn best when information is presented to us in this style. For example, visual learners prefer learning subject matter graphically or through other kinds of visual images. Kinaesthetic learners would learn more effectively if they could involve bodily movements in the learning process (Brown, 2003).

It is the learners' responsibility to adjust their learning styles to match their teachers' tutoring style(s). Learners need to be all-rounders in learning preferences so that they can adjust easily to the different teaching styles used by different teachers. They can do this by investing some energy in utilising underdeveloped or underutilised learning styles to improve their ability to adjust their cognitive styles when necessary. This proposed motivation method was hoped to encourage investment of energy in the utilisation of underdeveloped or underutilised learning styles, with a view to improving discourse among all the students regardless of their learning preferences (Brown, 2003).

2.6.6 Andragogy and Pedagogy

Andragogy was an educational concept relevant to the study as all the participants were young adults – eighteen years and older (Rastogi, 2013). As a result, they were considered suitably aged to be involved by their teachers in decision-making concerning their education. Andragogy refers to adult learning (Dunn, 2002) and is characterised by self-directedness. It embraces lessons which are learner-centred, problem-oriented and experience-based. Learner-centred lessons at high school are encouraged by the Ministry of Education and Training in Swaziland. The learner-centred approach lays the responsibility of learning in the hands of the student.

Students in this age bracket show variations in knowledge and life experiences. They come to the classroom with anxiety and feelings of low/high efficacy. Therefore, their learning is influenced by how they appraise or evaluate the new experience (Dunn, 2002). Those who interpret the new learning activity with feelings of fear and embarrassment are likely to disengage emotionally, whereas those who interpret it as exciting and challenging are likely to stay focused (ibid.). The main aim of the study, therefore, was to motivate those students who came to the classroom with feelings of anxiety and low efficacy by engaging them in a motivational method, so that they could find the learning experience exciting and challenging.

Andragogy is not used alone, however, in the teaching/learning process. Pedagogy also comes in as an integral part of andragogy, even when it involves the teaching of adult learners. This is because all teaching strategies, regardless of learner age, are pedagogical (Rastogi, 2013). Pedagogy helps in shaping thought processes – even in adults – especially when the adult mind is confused and unable to make a decision (ibid.). Pedagogy and andragogy were required to help engage those learners who might have disengaged emotionally from learning. Likewise, the proposed motivational method had a blend of both pedagogical and andragogical features.

2.7 Conclusions of the Chapter

Literature which formed the main framework for the study was critically reviewed in this chapter, covering learning theories, student discourse and motivation theories. The reviewed literature helped the researcher formulate the research design and methods for data collection described in the next chapter. The discussion of the findings of the study will also be in line with the reviewed literature. In fact, the rest of the research rests heavily upon the reviewed literature. The chapter that follows describes in detail the type of research to be conducted and the methods used for collecting data. It also explores the ethical considerations, validity, and reliability of the study.

Chapter Three: Research Design and Methods

3.1 Introduction

This chapter begins by restating the main aim and objectives of the study, followed by a clear description of the research design and methods. The study centred on motivating high school natural science students to engage more in classroom interactions and, thus, followed a qualitative design. Methods for data collection were those used by qualitative researchers, such as interviews, document analysis and observations; with research ethics strictly adhered to. All of the participants were selected purposefully. Data were collected from high school natural science students and their teachers. The chapter then closes with a concluding section that connects with Chapter Four.

3.2 Research aim and objectives

The main aim of the study was to improve effective communication during natural science lessons at a high school. The study was thus structured to achieve the following objectives:

- to find out how classroom discourse relates to natural science understanding;
- to find out if external motivation improves discourse during natural science lessons;
- to assess the effect of feedback during natural science learning;
- to explore ways of enhancing feedback during natural science learning; and
- to find out which teaching strategies improve interactions during natural science lessons.

3.3 Research design and methods

The research design and methods guiding this study are as follows:

3.3.1 Research design

A qualitative, exploratory, descriptive, and contextual design was utilised (Mouton & Marais, 1990; Burns & Grove, 1993). The qualitative approach used was ethnomethodology, the variant employed by linguistic ethnomethodologists (Cohen, Manion & Morrison, 2002). Research design referred to the way data was gathered from the participants (McMillan, 2004). The research was qualitative in that it explored traits of students and settings that could not be easily described numerically (Charles, 1995). It explored interactions of students with each other and with their science teacher in the classroom to describe and enhance their motivation to learn. The qualitative research helped the researcher generate an in-depth account that presented perceptions of students' realities within the classroom context (Gerrish & Lathlean, 2015). The data were obtained directly from the sources (McMillan, 2004) and required the researcher to be a good listener, non-judgmental, friendly, open, honest, and flexible (Gerrish & Lathlean, 2015).

The science teachers selected those teaching methods that boosted their students' understanding and morals, thus, helping the students to achieve better results in the sciences through improved discourse. The researcher did not impose pre-existing expectations on the participants (Mouton & Marais, 1990). A qualitative approach was used because it allowed the design to evolve during the study (McMillan, 2004). Moreover, the data obtained from the participants was mainly verbal. The most data obtained were from interviews with the participants.

Case studies were used for this research. McMillan (2004) defined a case study as an investigation of an entity carefully defined and characterised by place and time. For this study, the entities were two natural science groups (a chemistry group and a physics group) in a high school in the southern part of Swaziland. McMillan (2004) further described a case study as an in-depth analysis of one or more events, settings, programmes, social groups, communities, individuals, or other bounded systems. The case study design was suitable because it was not frequencies of occurrences that characterised the study, but quality and intensity (Cohen et al., 2002). A case study separates the significant few from the insignificant many instances of behaviour. So, significance rather than frequency is the hallmark of case studies.

The collected data were analysed in depth to elicit the levels and patterns of student discourse during science learning. Cohen et al. (2002) defined a case study as a specific instance that illustrated a more general principle. The general principle for this study that emanated after data analysis was the relationship between student motivation and classroom discourse. All the above definitions of a case study were adopted in this study.

3.3.2 Research methods

Data for the research were collected using observations, interviews, and analysing documents such as classwork, assignments, quizzes, tests, and examination scripts. During data collection, a passive physics group, together with a somewhat vibrant chemistry group, was encouraged to participate actively in the teaching/learning process by being awarded points. The points were later converted into percentage marks and added to the students' continuous assessment (CA) scores (see Figure 4.2.2).

3.3.2.1 Observations

The type of case study used for this research was observational (McMillan, 2004). The observations allowed the researcher to probe deeply and analyse intensively so as to make generalisations (Cohen et al., 2002). The non-participant observational method was used (ibid). Non-participant observations minimised the disturbance of the natural set-up of the classroom or laboratory. Participant observation was almost impossible because of age and status differences between the students and the researcher. Observations carried out while watching and listening were valuable to a qualitative-oriented researcher because what was observed was actually what the researcher experienced (Ellens, 2008).

The researcher was introduced to each natural science group by its science teacher before lesson observations began. The students were told the main aim of the lesson observations and the duration of data collection. The researcher sat at the back or along the sides of the classroom or laboratory and recorded the verbal interactions between the teacher and the participant students, and the interactions among the participant students as well.

The observations were recorded in the classroom observation tool (see Appendix E). Filling-in of the lesson observation instrument began before the start of the lesson by getting more information about the lesson from the science teacher and completing the Pre-Observation Data section. The instrument was completed after each observation. In most cases, the instrument was completed before asking the participants to come for post-observation interviews.

Of the three methods of data collection employed in this study, classroom observations seemed to cater for almost all the research sub-questions. The observations informed the researcher about classroom discourse and science understanding. The effect of external motivation on student discourse was observed, as well as the effect of feedback during learning. Ways and strategies that improved interactions during lessons were also observed.

3.3.2.2 Interviews

Interviews were thought suitable for the study because they were going to allow the interviewer and interviewees to discuss their interpretations of the world in which they lived. The interviewer used informal interviews and hoped to enjoy the freedom of modifying the sequence of questions, changing the wording, and even explaining or adding to the questions (Cohen et al., 2002).

The questions were few, semi-structured, and open-ended, with probes for eliciting more information from the interviewees (see Appendix D). The student participants, together with their natural science teacher, were interviewed on the value they placed on discourse for learning purposes. They were interviewed after each lesson observation. The interviews were conducted in a preparation room inside a science laboratory, which was quieter and more private than the general laboratory. Probably, the participants were going to feel relaxed and free to express their views about their education.

A voice-recorder was used for capturing the interviews. It was a small, hand-held digital device which could not intimidate the interviewees by its size. The interview questions were divided into two sets: one for the pre-motivation phase and another for the motivation phase (see Appendix D). Each phase had a set of questions for the teacher and another for the students. The questions for each phase of data collection were printed on an A4 sheet of paper for use by the interviewer.

The questions to be asked during the interviews with the participants would answer all the research sub-questions. So, the interviews were going to be very informative because they would allow the participants to reflect on their insight and experiences of the teaching/learning process. Thus, the data from the interviews would form the largest part of the reported data. The biggest challenge was having interviews during sports time because some of the participants were active members of sporting activities. Another challenge was that of unexpected intruders during the interviews. Putting those challenges aside, the one-on-one interactions seemed were going to be the best in providing verbal data.

3.3.2.3 Documents

Students' classwork, assignments, quizzes, tests, and examination scripts (see Appendix F) were to be collected from participants and used as primary sources of data (ibid). The science teachers' records (see Appendix F) for students' performance were going to be used as sources of data. The students' documents would be requested after being checked by the science teacher for assessment. Data from the documents would be used for comparison to see if students had improved in performance after motivation.

Data from student documents would provide answers to three of the five research sub-questions. The documents would show the relationship between classroom discourse and science understanding. The documents would also show the effects of external motivation on classroom discourse. Lastly, the documents would be informative about the effects of feedback during natural science learning.

The research was conducted in two phases:

1. observations of two passive natural science groups; and
2. observations of the same two groups after being motivated.

Phase 1: Observations of two passive natural science groups

This phase was concerned with collecting data from two Form 4 Natural science groups. Those were groups of 45 students each, which were taught natural science in the traditional way. Most of the lessons were teacher-centred and conducted in the classroom. Information from the participants was going to be collected using the data collection methods described previously. Data collection for Phase 1 would follow immediately after the pilot stage described in Section 3.5. Each method of data collection would have its own challenges. For example, setting the right time for conducting some of the interviews immediately after lesson observations would prove difficult. That would be particularly so with lessons that were to be followed by other lessons. Another challenge would be receiving students' scripts after they had been given back by their teacher. The best option would be getting them from the science teachers before returning them to the students.
The lesson observation tool (Appendix E) had a section (Pre-Observation Data) which had to be filled in before lesson observation with the help of the science teacher. There was another section (Reflections and Interpretations) which had to be filled in immediately after the lesson observation. Pencil had to be used in the lesson observation tool in case of mistakes, alterations, or cancellations of lessons. Phase 1 lasted for about four months.

Phase 2: Observations of two motivated natural science groups

During this phase, data were collected from the same students who participated in Phase 1, using the same methods. The science teachers used the method described in Section 3.3 to motivate their students during the lessons, i.e., the award of marks for positive contribution during science lessons. Even their teaching methods moved away from being teacher-centred to being learner-centred. The teachers engaged their students more in discussions and discovery learning. As with the first, this phase lasted about four months.

3.4 Population and Sampling

Teachers in the science department helped in identifying the most passive Form 4 science group for use in the research. They identified a class of 45 students (20 girls and 25 boys). The researcher then approached a Chemistry teacher and a Physics teacher, who taught the group Physical Science, to seek permission to do data collection with them. The researcher then selected six students of mixed sexes from the Form 4 natural science group as purposive sampling. Both boys and girls were chosen for fairness and improved validity. The students were sampled in boy and girl pairs according to their levels of passivity. Two students were highly conversant during science lessons, one with high marks and the other with low marks. Another two were moderately conversant students, one with high marks and the other with low marks. Lastly were two poorly conversant students, one with high marks and the other with low marks. These students were observed and interviewed, with their responses audio-recorded using a voice-recorder. Three were selected for Chemistry observations and interviews, while the other three were selected for the Physics component of Physical Science.

The science teachers were also interviewed and their responses audio-recorded. The interview questions were few, semi-structured and with probes to elicit more information from the interviewees. Data collection was done in two phases, the first being a pre-motivation phase and the second being a motivation phase. Access to the science students was through the director of education, the regional education officer, the grantee for national schools, the school principal, and their science teacher. The researcher secured a letter of consent from the sampled students before they got involved in the research. This was the sample that was observed and interviewed during data collection.

3.5 Data Collection

A pilot study was conducted with four participants, two for Chemistry and two for the Physics component of Physical science, for a few lessons before engaging in the main study. This was done to avoid possible problems that could occur during data collection. The four participants were not used in the main study, but for the pilot study only. The pilot study showed no problems with the data collection methods and, as such, the main study was carried on. Data was collected according to the methods discussed in this section on research methods. Six participant students were observed during natural science lessons. Their interactions with their science teachers and their colleagues were noted on paper (Appendix E: Classroom Observation Protocol). They were interviewed after each observed lesson about their emotions and on the value they placed on science and on science discourse. Their Physical science teachers were interviewed about their students' motivation to learn science and the effort they put into science discourse.

The students were interviewed one at a time in a welcoming and relaxed atmosphere to elicit genuine data. The interview questions were read from an A4 paper. The researcher listened attentively and communicated in simple language so that the participants could speak with ease and without inhibition (Speziale, Streubert & Carpenter, 2011). The small Dictaphone for recording the interviews was put on a desk next to the researcher and the interviewee. Because of its small size, it never intimidated the interviewees. The researcher was flexible, objective, empathic and persuasive during the interviews to elicit as much data as possible from the participants. Other communication techniques used by the researcher to gather as much data as possible included probing, paraphrasing and minimal response. Minimal response meant allowing the participants more time to think out their responses and talk, with the researcher assuming a less active role (Kopala & Keitel, 2003).

The interviews were audio-recorded for data analysis purposes. During data collection, the participants' non-verbal cues were noted. Those cues included gestures, movements, tone of voice, posture, repetition and stammering. The cues were important to the study since they reflected the participants' emotions. The participants' classwork, tests and examination scripts were collected and examined to assess how they were performing. Their performances were noted and then used for comparison purposes during the second phase of data collection. The documents were photocopied and returned to the students (see Appendix F). The quality and quantity of discourse in the documents was used during data analysis. This method of data collection answered the main question for the study, and its sub-questions.

3.6 Motivation method

The two groups of natural science students were motivated according to the method described below. The proposed motivational method was suitable for use with a number of teaching strategies such as a practical, debate or a lecture. The science teachers administered the method with the help of the researcher. A student, who asked, answered or suggested relevantly during a lesson scored 0.5%. A kind academic gesture, such as dusting the chalkboard for the teacher, also scored 0.5%, depending on the teacher's discretion. Once a student reached 5%, 0.5% was awarded after three successful attempts and the term mark was rounded down. For example, 84.5% was rounded down to 84%. That was a control measure to prevent students from scoring above 100% through this method. The marks scored using this method were added to the student's continuous assessment (CA) final mark. The exercise started afresh each term.

Students were chosen on a first come, first served basis. The first one to raise up a hand to make an attempt was given the first chance. The researcher chose from the participants while the science teacher chose from the rest of the class. The participants were given the first chance, then the rest of the class. In the absence of the researcher, the science teacher carried out the exercise in the same order.

3.7 Transcription

The audio-recorded data were transcribed into written work by the researcher. The audio-recorded data improved the reliability (member checking) and internal validity of the results, as well as the researcher's interpretations of the data and conclusions. However, that was accompanied by loss of some properties of speech such as pronunciation, rhythm and intonation. Nonetheless, the researcher tried to transcribe as much non-verbal communication as possible to retain the context (Gee, Michaels & O'Connor, 1992) and make the transcripts as representative of the original interviews as possible.

3.8 Data Analysis

Data were analysed using the thematic discourse analysis approach (Clarke & Kitzinger, 2004), a method which focuses on identifying patterned meaning across a dataset (Boyatzis, 1998). Boyatzis (1998) describes thematic analysis as a theoretically flexible method that suits questions related to people's experiences or views and perceptions, as well as questions relating to the construction of meaning. It is a structuring scheme that people utilise when they want to understand the world and themselves; when they interpret a situation and talk and act in this situation (Cruickshank, 2012). Braun and Clarke (2006) define thematic analysis as an analytic method for identifying, analysing and reporting patterns within data. It interprets various aspects of the research topic (ibid.). The aspects of this research topic interpreted were discourse, motivation, case study and teaching.

Discourse analysis can be applied to interviews, letters, diaries, public documents, observations, newspaper articles, etc. (Cruickshank, 2012). This method of qualitative data analysis has been used with success by many researchers such as Clarke and Kitzinger (2004) and Braun and Clarke (2006). The patterns identified within data are called themes. For this research the themes identified were student-student, student-teacher, student-researcher and teacher-researcher interactions. The audio-recorded data were transcribed, coded, categorised into themes and then interpreted. The themes were decided after data collection according to identified codes. The themes captured something important about the data in relation to the research question (Braun & Clarke, 2006).

Braun and Clarke (2006) have developed a guide for conducting thematic analysis. The guide comprises six phases:

1. Becoming familiar with the data
2. Generating initial codes
3. Searching for themes
4. Reviewing themes
5. Defining and naming themes
6. Reporting

The collected discourses were grouped into two segments, with each segment being a unit of analysis. One segment of discourse comprised the student-student, researcher-student, researcher-teacher, and teacher-student interchanges. The other segment of discourse comprised the students' written natural science work. Each segment was analysed according to where the terms used by the students lay along a continuum of understanding, with one end of the continuum representing everyday discourses and the other end representing scientific discourses. The data from lesson observations - frequencies of interactions during lesson time, gestures, facial appearance, posture, enthusiasm in their spoken discourse and in doing and submitting their science work, etc. – assisted the researcher to indirectly measure the students' levels of motivation through comparing the results for the two phases. Their marks in natural science assignments for the two phases were also used as an indicator for motivation.

3.9 Credibility

Credibility is the extent to which data, data analysis and conclusions are believable and trustworthy (McMillan, 2004). The credibility of a qualitative study is governed by the principles of triangulation, reliability and validity.

3.9.1 Triangulation

Triangulation is the use of different techniques in collecting data so that the data can be compared (McMillan, 2004). If the different techniques give the same data, then the finding is judged to be credible. For this study, triangulation was assured by collecting data using a classroom observation tool, an interview schedule and document analysis. Analyses of the data obtained using the three methods of data collection led to the same findings, considering the main question for the research. The main research question was

- Can student motivation enhance classroom discourse for improved natural science understanding?

The data from lesson observations, interviews and documents addressed the main question in totality by answering the five sub-questions, to different extents. Triangulation is a good and powerful way of demonstrating concurrent validity, especially in qualitative research (Cohen et al., 2002). The more the data from the different methods correspond, the more confident the researcher is about the findings (ibid.).

3.9.2 Reliability

The reliability of a qualitative study is judged by the extent to which recorded data agrees with what actually occurred in the setting that was studied (McMillan, 2004). Cohen et al. (2002) define it as a fit between what a researcher records as data and what actually occurs in the natural setting. Reliable data helps in comparability with data for other studies for extent of generalisability. For this study, a voice-recorder and member checking were used to enhance reliability of the data. Member checking was done by giving the participants the researcher's field notes to read while listening to the audio-recorded interviews for verification (Speziale et al., 2011). Reliability of the interviews was also enhanced by the careful formulation of questions so that meanings were clear, there was avoidance of leading questions, and careful piloting of the interview tool. Reliability and validity of the study were also addressed by the triangulation of data sources and methodologies.

3.9.3 Validity

Cohen et al. (2002) define validity for qualitative data as the degree of honesty, depth, richness and scope of data achieved by the researcher. It is the extent to which interpretations of data will be deemed appropriate, meaningful and useful (McCown et al., 1996).Validity of data ensures reliability and trustworthiness of the data and the methods used for data collection. Validity is also determined by the participants approached, the extent of triangulation and the disinterestedness or objectivity of the researcher (McMillan, 2004). However, it is impossible for research to be 100% valid; thus validity should be seen as a matter of degree rather than an absolute state (Cohen et al., 2002). Moreover, the researcher is part of the researched world and cannot be completely objective about it.

The validity of this study was not attached to the data or methods used but to the meanings that participants gave to the data and the inferences drawn from it. (Blumenfeld-Jones, 1995). Of all the kinds of validity presented by Maxwell (1992) four were relevant to this study and are descriptive, interpretive, and theoretical validity, as well as generalisability. These four kinds of validity helped in understanding the study.

- *Descriptive validity* – It is the accuracy of the account that is not made up, selective or distorted. The account should narrate what actually happened.
- *Interpretive validity* – It is the ability of the research to capture the meaning, interpretations, terms, intentions that events and situations have for the participants themselves, in their own terms. It refers to the subjective meaning – what it means to the researched person or group.

- *Theoretical validity* – It refers to the extent to which the research explains phenomena.
- *Generalisability* – the view that the theory or explanation generated may be useful in understanding other similar situations. Generalising can be done within specific groups or communities or in situations far beyond them.

Qualitative studies have internal and external validity.

3.9.3.1 Internal validity

Internal validity is the extent to which the explanation of a particular event, issue or research data is truly sustained by the data (Cohen et al., 2002). It is the accuracy of the explanation of research data (ibid). McMillan (2004) defines it as the match between the researcher's categories and interpretations and what is actually true. Is a pattern actual or does it have limitations in the data gathering aspect or has the situation distorted the findings? In short, the findings must accurately describe the phenomenon that is being researched (Cohen et al., 2002).

Qualitative researchers need to take caution as their subjectivity and potential bias may threaten the credibility of a research. Internal validity in this research was maximised by making the study long and intensive to avoid subjectivity and biasness, and by triangulating the data (McMillan, 2004). Detailed field notes also diminished the researcher's subjective opinions and improved understanding of the context. Observer effects were minimised by unobtrusive entry and participation (Cohen et al., 2002) into the science classroom (laboratory), thus maintaining its natural settings. Repeated patterns of observations also enhanced internal validity.

3.9.3.2 External validity

External validity is the degree to which results can be generalised to the wider population, in other cases or situations (Cohen et al., 2002). External validity is often weak in qualitative studies because the purpose is not to generalise to a larger population, but to increase understanding about a phenomenon (McMillan, 2004). Moreover, the methods used in a qualitative study are unique to that study. Translatability and comparability are the terms used in qualitative studies where the emphasis is on how well the data, categories, analyses and patterns are described and, how well other researchers can interpret the findings so that they can be used in other settings (ibid).

However, other authors argue that generalisability is possible in qualitative research as long as the researcher provides a clear, detailed and in-depth description of findings so that others can decide the extent of generalising to other situations (Cohen et al., 2002). Therefore, it was hoped that since the findings of this study were described coherently, with details given in depth, other researchers could generalise these findings to other situations. The study seemed to have a greater degree of translatability and comparability to other schools and situations in Swaziland and probably elsewhere.

3.10 Ethical Considerations

Ethical clearance to collect data for this study was sought from and granted by the University of South Africa, College of Education Research Ethics Review Committee. The rights of the participants were observed during the study and thereafter (Speziale et al., 2011). Ethics of research were observed by the researcher and participants and appropriate respect, trust and autonomy were imparted during the study. Some of the research ethics observed during data collection were informed consent, confidentiality, beneficence, anonymity and non-malfeasance. Cohen et al. (2002) state that three research ethics need to be observed during the collection of data using interviews.

The permission to collect data from the school in order to conduct the study was sought from the Regional Education Officer beforehand (Appendix A). The permission was then granted by the Director of Education from the Ministry of Education and Training (Appendix A1). Consent (Appendix B) was sought from two natural science teachers (one for Physics and the other for Chemistry) and also from the participant students (Appendix

C). The purpose of the study was explained to all the parties concerned and permission was obtained to proceed with the investigation.

The participants were assured confidentiality. They were asked to use an alias of their own origin. Access to the data was controlled as a measure of maintaining confidentiality of the participants. The benefits of the results of the study and the consequences of the interviews were explained to the participants, and they were assured that the results would be harmless too with complete non-malificence. The interviews had an ethical dimension because they dealt with interpersonal interactions and produced information about the human condition.

3.11Conclusion of Chapter three

In this chapter, the research design and methods were described. The main aim and objectives of the study were restated. Detailed descriptions of how data were transcribed, analysed and verified were given. The chapter also explained in detail about the method that was used in motivating the students to engage actively during science lessons. Credibility of the study was addressed in detail, especially triangulation and validity. A detailed description of some ethical considerations was also given. These were ethical standards like informed consent, confidentiality and anonymity. The next chapter (chapter 4) focuses on how the collected data were presented, analysed and discussed.

Chapter four: Analysis and Discussion of Results

4.1 Overview

Results of the study are presented and analysed in this chapter. They were analysed using the thematic discourse analysis approach. Patterns of similarities were identified among the data and used in grouping the data. Each group of similar data was then coded. Similar codes were then identified and brought together and given a common name (theme). Nine categories were identified and are shown in Figure 4.1. The data were interpreted and discussed with reference to the literature reviewed in chapter two. The chapter was then concluded.

4.2 Data analysis

Data from the two phases of data collection were analysed concurrently for comparison purposes. The data were categorised into two segments – one segment comprising researcher-student, researcher-teacher, teacher-student and student-student interactions; while the other segment comprised the students' written science work. The categorisation of the data was then presented in a diagrammatic form as follows (Fig. 4.1):

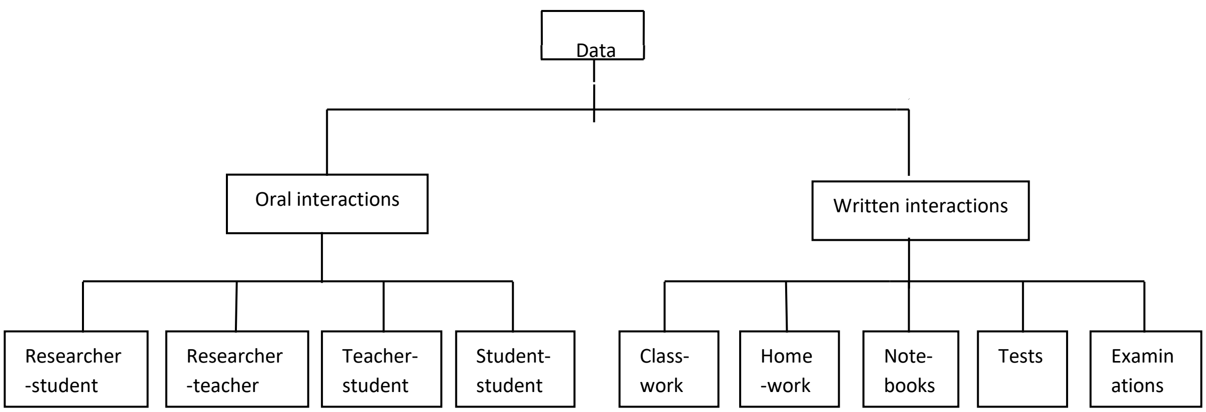


Figure 4.1: Categorisation of research data for analysis.

The oral data were obtained from the interviews conducted by the researcher, as well as from lesson observations. The written data were obtained from the students' documents during lesson observations. Each segment (oral or written interactions) was a unit of analysis and was analysed according to the students' levels of engagement in science discourses, and also according to where the terms used aligned to a continuum of understanding (Fig. 4.2):

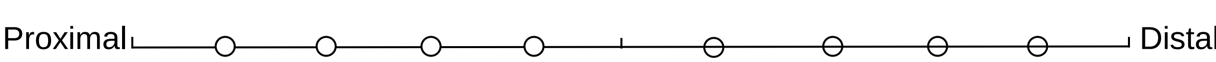


Figure 4.2: Continuum for student understanding of scientific terms.

4.2.1 Oral interactions

The oral interactions were coded according to the people interacting for the cases of researcher-student, researcher-teacher, teacher-student and student-student interactions. The coded oral interactions were then analysed according to their methods of data collection, that is, through interviews and lesson observations (see Fig. 4.3).

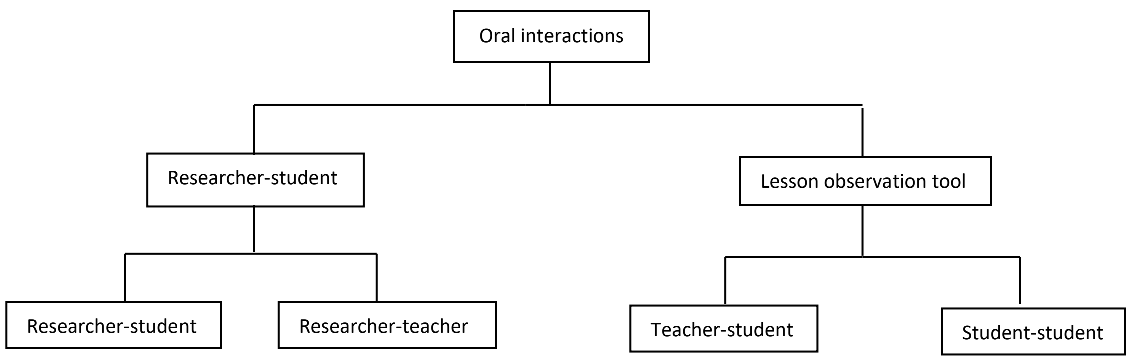


Figure 4.3: Types of interactions yielding oral data.

Oral interactions yielded the largest amount of data for the study compared to the data obtained from documents.

4.2.1.1 Interviews

The interviews were audio-recorded using a digital voice-recorder. They were then transferred into a laptop for easy manipulation during transcription. The hand written interviews covered two hundred A4 pages. Eighty-four of the two hundred pages were filled with the data for the pre-motivation phase. That could be interpreted to mean the participants were more conversant during the motivation phase than during the pre-motivation phase. Secondly, only one interview was missed by a participant during the motivation stage compared to three interviews that participants missed during the pre-motivation phase.

Interviews were employed as one of the methods of data collection for the study since they were thought to provide detailed data which would meet the main aim of the study. The main aim of the study was to improve effective communication during natural science lessons at high school. Data from interviews also answered the research question:

Can student motivation enhance classroom discourse for improved natural science understanding?

The data from the interviews also gave answers to all the following research sub-questions:

(a) How does classroom discourse relate to natural science understanding?
(b) What is the effect of external motivation on discourse during natural science lessons?
(c) What is the effect of feedback during natural science learning?
(d) How can feedback be enhanced in the natural science class?
(e) Which teaching strategies improve interactions during natural science learning?

Data from the interviews were categorised into three themes- namely, motivation, talk and performance. Each theme was analysed under the two types of interviews, namely, researcher-student and researcher-teacher. Following is a diagrammatic representation of the themes for the interview data:

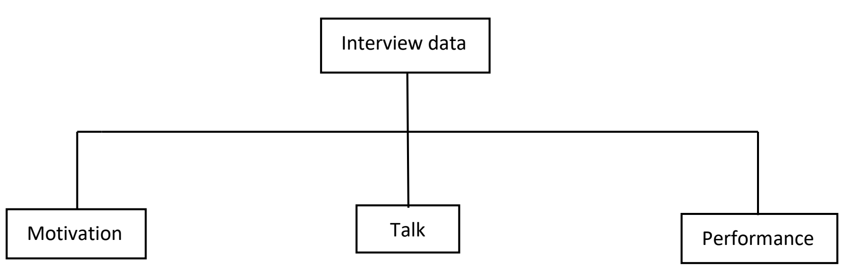


Figure 4.4: Themes for the interview data.

4.2.1.1.1 Motivation

Interview questions for the students which were classified under the theme *motivation* were:

1. In your view is chemistry an interesting subject?
2. Are you happy about the way chemistry/physics is taught?
3. Should this motivation method used with you be adopted by other teachers?

4.2.1.1.1.1 Researcher-student and researcher-teacher interviews

Researcher-student interviews yielded the largest amount of data compared to researcher-teacher interviews. That was because there were more student participants (six) than teacher participants (two). The participants used an alias of their names. There were three girls (Daluthando, Tiny and Goodwill) and three boys (Nkhosinathi, Mlungisi and Fortune). Data from the researcher-student interviews were the first to be analysed under each theme, followed by data from the researcher-teacher interviews. Interview question:

In your view is chemistry/physics an interesting subject?

During the interviews held with Daluthando in the pre-motivation phase, she expressed her poor interest in physics. It was only during the first interview with her when she said that physics was *sometimes* an interesting subject. When asked why she found physics less interesting, she cited difficulty of the subject and that it involved many mathematics calculations. The following abstracts quote her responses to the researcher's question if physics was an interesting subject:

"...physics is not an interesting subject because you need to be a hard worker when you're doing physics."

"Physics needs a lot of calculating like in mathematics questions, which is difficult."

"Sometimes; because physics is not an easy subject. It needs a hard worker to do and it involves calculations."

So, for her, one would say if there was a way of eliminating physical science from her list of subjects she would drop that subject. Though Daluthando mentioned calculations as the main factor making her lose interest in physics; the issue of 'a hard worker' in physics which she mentioned more than once would be indicative of loss of interest on her part. Daluthando still maintained that physics was a difficult subject even during the first interview of the motivational phase. However, from the second interview of the motivational phase she started expressing her appreciation of the subject though it was difficult. Here is a quote to illustrate this:

"Sometimes I find difficulties, sometimes I find it interesting. [Physics] is difficult because it needs lots of calculations and the[re are] formulas; which are sometimes difficult to cram)."

Daluthando had started to develop an interest in physics by the second interview of the motivational phase. However, the word 'cram' that Daluthando used to express how she prepared for physics was of concern. It implied that she did not strive to understand, which is the main goal of science instruction (Matthews, 1993), and is necessary to master physics content. She simply relied on cramming to pass her tests and exams. The danger with practices such as cramming is that they usually lead to ill-preparedness for tests and exams (Averill, 1973, Denga, 1983 and Ekezie, 2000). Ill-prepared students usually lack self-confidence and develop low self-esteem (ibid., year). This can lead to exam malpractices; including the exchanging of information during exams (Onuka & Obialo, 2004).

Subjects involving a lot of abstract concepts; such as sciences and mathematics are found by most students to be too challenging because these subjects usually demand reflexive abstraction (McCown et al., 1996). However, there is now a global initiative that encourages girls to take up careers in science, mathematics, engineering, and technology.

It is important to note that Daluthando was not the only girl struggling with calculations in physics; Tiny, another girl who was interviewed about physics had the same challenge. The following abstracts express her responses to two questions: (a) if she found physics interesting and (b) why or why not this was the case. These abstracts were taken from three successive interviews held during the pre-motivation stage:

> "Ah... not really. Because it involves a lot of counting and math is a bit challenging to me."
>
> "It is not. There is too much calculating. So, me and math, it's something else."
> "It is not an interesting subject because there is so much counting, and you know, equations and stuff. So, I'm not good at math."

Both girls admitted that they were challenged by the calculations in physics to the point of losing interest in the subject. Tiny had even come to accept that she was not good at mathematics altogether. This was a sign that she needed some motivation to start appreciating sciences and mathematics; something that was true for both girls. Their teacher had even mentioned in one of his interviews, that it seemed that some of the students already came to school with the preconception that physics was a difficult subject.

Daluthando expressed her appreciation for the theoretical aspect of physics, but not the calculations. Despite the fact that calculations formed a good part of physics. Whereas, Tiny continued to maintain her lack of interest in physics, even during the interviews for the motivation phase. It was only during the third interview where she responded to the same two questions that Tiny had previously answered that she indicated this lack of interest in physics:

> "It is not that interesting. It is just a subject. It's just that it's a bit challenging to me."

This abstract indicates that physics was challenging for Tiny, but that the motivation method succeeded by helping her to start developing an interest in physics. This method even allowed her to succeed in physics. According to the achievement motivation theory experiencing success increases the need to want to achieve (Brennen, 2012). She needed scaffolding and intersubjectivity (McCown et. al., 1996) to move her along her zone of proximal development in physics.

Interviews conducted with Fortune (a boy) about physics garnered different results from those of Daluthando and Tiny, previously interviewed. When Fortune was interviewed it was revealed during both phases that he found physics interesting and appreciated the calculations involved in physics. The following abstracts are his responses during some of the interviews held with him. When asked: (a) if physics was an interesting subject and (b) why or why not this was the case.

> "Yes, it is interesting Sir. The reason is that I like mathematics equations. So, it contains a lot [of those] and it even helps me to overcome these math equations."

> "Yes, it is interesting Sir. It contains some mathematical equations, which help me to overcome these math problems."

> "Yes, it is interesting Sir. It contains some math formulas, which help me to have enough practice and also to [be able to] pass the subject."

Fortune appreciated the fact that physics involved math equations. He also found physics and equations to be complimentary of each other, as the equations in physics gave Fortune more time to practice his numerical skills. However, during the second phase of interviews, he hinted that physics was becoming more difficult than he had previously found it to be. This is seen in this abstract:

> "Yes, it is interesting. But now it seems to [have] become [more] difficult than before."

Indeed, it is true that as more concepts are learned they become interwoven and thus get more complex. It could also be considered that new concepts do not fit into existing schemes, meaning that there is no assimilation and accommodation, but in fact, disequilibria (Posner et al., 1982).

All of the respondents; two boys and a girl found chemistry to be an interesting subject when interviewed about this component of physical science. The next abstract quotes Mlungisi's response when he was asked if chemistry was an interesting subject and why.

> "Yes Sir. Chemistry is an interesting subject since there are many things in chemistry that you may not [always] believe, but they are there. Interesting things such as the movement of electrons in the structure of an atom."

From this abstract it is clear that Mlungisi was a good student for chemistry; as he appreciated the abstract content that needed imagination, which included electrons moving in an atom. This is called cognitive learning and is a 'must' if someone is to cope with complex abstract information (Louw & Edwards, 2010). Abstract content is learned best through cognitive maps. Mlungisi also contributed to the interviews by adding a very important aspect of human beings, their belief system. Beliefs are a great hindrance to the understanding of scientific explanations for most students. Once a scientific explanation is contrary to one's pre-conceived knowledge or beliefs, then students and human beings, in general, can find it very difficult to accept the scientific explanation. Mlungisi insisted that belief needed to be applied to content for chemistry. In the following abstract from the second interview held with Mlungisi during the pre-motivation phase this is evident:

> "Yes, chemistry is an interesting subject since it widens the mind. There are many interesting things that you cannot believe, although they are there."

To emphasise his interest in the subject Mlungisi made this statement to make the claim that chemistry can widen the mind and uncover hidden things. Mlungisi again brought up the issue of belief during phase two of the interviews when asked why he found chemistry interesting. Here is another abstract to this effect:

> "Yes Sir, according to my view chemistry is indeed an interesting subject. There are many things to learn about in chemistry. Some of them you cannot believe, some of them you can. That's why according to me it is interesting."

Beliefs are very important in formal learning because they are part of the preconceived knowledge students bring with them into the formal learning environment, and they are very difficult or sometimes even impossible to eradicate from the students' brains. What has to occur in such a situation is assimilation and accommodation for conceptual change to take place (Vygotsky, 1978). Thus, students need to be flexible in the formal set-up so that formal education can improve or even change the beliefs they construct in informal settings.

In the next abstract Mlungisi revealed what made him believe the things he learned in chemistry:

> "There are many things in chemistry which one cannot believe, but as you go on with the experiments you tend to [start to] believe [them]."

From this statement according to Mlungisi, experiments are a very important part of the sciences because they help to seal the information in the brain. Though Mlungisi was in the formal operational stage of cognitive development according to Piaget (1978) he at times regressed to the concrete operational stage of cognitive development (McCown et al., 1996). That usually happens when new concepts are too abstract or difficult to assimilate or accommodate into existing schemata. Experiments then make it easy for the existing schemata to assimilate and accommodate the new concepts.

Goodwill, the only girl interviewed in this study said that chemistry interested her because the subject informed her about her environment and about the latest technology. Here is an abstract of the first interview held with her during the pre-motivation phase:

> "Yes, chemistry is an interesting subject because in chemistry we get to find new ideas about the environment, the atmosphere, and new technology about things."

From this abstract, it can be determined that Goodwill seems to be an up-to-date student; ready to learn new things; who is conscious of her environment. During one of the interviews during the motivation phase, Goodwill gave a lengthy account of why she found chemistry interesting. During this time the researcher continued to motivate her by asking her further questions. Her response is as follows:

> "So far to me, chemistry is a very interesting subject. For example, what I like most, [is that] in my first lesson in chemistry we discussed the importance of chemistry in society. Our teacher told us that chemistry is useful when it comes to making medicine for treating sick people. To me [this] is a very interesting subject. It allows one to focus on the environment. What is happening around us, in class, and even reading about chemistry."

> "Yes, [it is] very interesting because there are new discoveries of new methods and ideas. I like new things and my thinking ability is improved. Even my vocabulary [is improved] because chemistry is [taught] in English [and] improve[s] my vocabulary."

> "Yes, and it's so interesting [because] it is good to speak [about] these scientific words because someone might want to know what you mean by these terms. What are you talking about?"

> "In chemistry, there are these questions, like in math, which need one to think fast or be able to calculate things. So, I can say math is all about calculations,[but] in chemistry there are [also] calculations. So, our minds get used to calculations."

> "I like calculations. I like working with numbers and chemistry is boosting [to] me."

Therefore, it is fair to say that Goodwill had the opposite opinion of Daluthando and Tiny; who did not have an interest in physics because it involved mathematical calculations. Goodwill appreciated calculations and enjoyed both chemistry and mathematics. The first chemistry lesson about the importance of chemistry to society inspired Goodwill; suggesting that once she completed school she might choose a career in the sciences; especially a career to do with human health or the environment. The abstracts portray her as a student with multiple intelligences. Those could be intelligences such as verbal/linguistic and logical/mathematical (LDPride.net, 2015).

Students like Goodwill and Mlungisi can be easier to teach sciences because they are usually self-regulated (Bandura, 1986). As they learn, they have an academic goal they want to achieve. Goodwill was aware that her vocabulary and thinking ability needed to be improved. In the third abstract she even mentioned a very important aspect of learning – speaking. Putting the scientific terms into practice makes it easier to recall their meanings and applications even in the future. It is another way of internalizing them (McCown et. al., 1996), as she was forming her thoughts (Vygotsky, 1978).

According to Tanner (2009), talking enables a student to process information. Tanner (2009) also states that students talking is valuable to teachers because it (a) enriches the individual student's learning experience; (b) provides teachers with insight into students' cognition; and (c) promotes a collaborative culture among students. When Goodwill began chemistry, the scientific terms frightened her. However, as she continued to learn she got used to them and began to use them with pride. She revealed this during the motivation phase, as shown in the abstract below:

> ".... At first, it was a very challenging subject because there are these scientific names which [I had only heard of and then seen for the] first time. So, I was wondering what's the meaning of these words? Am I going to make it? And I had just heard some rumours [of] people saying 'Ah, chemistry is challenging. Chemistry is bad. But I haven't seen that so far."

Goodwill contradicted herself in this abstract. She mentioned that when she started chemistry the scientific terms she learned made the subject challenging for her. However, towards the end of the abstract, she mentioned that by the time she was interviewed she had not experienced any challenges in chemistry, despite the rumours she had heard. The scientific names that frightened Goodwill were part of the language of science. The language of science is used when communicating science concepts (Singteach, 2014). It threatens many students and hinders them from learning science concepts.

It is important to mention that Tiny and Daluthando did not mention problems with the language of science and that Daluthando even expressed her appreciation of the theoretical part of physics. In science, students are not only challenged by the terms used; but even by figures, graphs and pictures (Haim, 2010). Thus, the motivation method encouraged Goodwill to engage more in chemistry discourse, allowing her to overcome the challenges she encountered and start to enjoy chemistry.

The third chemistry student to consider was Nkhosinathi. Nkhosinathi also found chemistry “interesting”. But the difference with him was that he’d said he found chemistry “interesting” because:

a) it demanded concentration from students, and
b) it was not difficult.

Following are two abstracts from two different interviews held with him, during phase one:

> “Chemistry is an interesting subject, since you have to concentrate while the teacher teaches.”

> “It is not a difficult subject. When you don’t understand, you have to approach the teacher and ask for more information.”

According to Nkhosinathi, students needed to pay more attention to chemistry, and if they did so, then they would find it an interesting subject to learn. He also mentioned something very important to every learner: seeking help when one faces challenges with a subject, from others more capable, in that subject. This could prove invaluable. Vygotsky termed that technique: “the zone of proximal development”. (http:www.learnnc.org/lp/pages/5075). The zone of proximal development is the gap between what a learner has mastered and what the learner can achieve, when provided with educational support in a social setting, by more knowledgeable and proficient people.

Nkhosinathi was specific to state, that the more knowledgeable or proficient person was the teacher, for the chemistry students. Even during the motivation phase, Nkhosinathi maintained that chemistry was an easy subject, so long as a student would focus on the teacher in class. Here are two abstracts from two different interviews conducted with him:

> “Chemistry is interesting, Sir. That’s a simple subject. You need to concentrate and catch up with the stuff.”

> “If you keep concentrating when the teacher is teaching, it makes it to be simple when it comes to tests.”

Seemingly, according to Nkhosinathi, concentration of students during lesson time was the key to academic success.

The physical science teachers were interviewed about the motivation of their science students (chemistry students and physics students). They were first asked if their students were motivated to learn physical science.

Question: Are your students motivated to learn chemistry/physics?

Following is a response the chemistry teacher gave to the question during the pre-motivation phase:

> “Yes, they are; but not that much motivated.”

So, the chemistry students were indeed motivated, though not up to a satisfactory level, according to their teacher.

On a second interview with the teacher, he expressed his concern that it seemed their motivation was still low. A reason the teacher gave was that he had returned some work he had given them to do on their own…Perhaps the results or feedback was disappointing to the students. Here is a transcript of the teacher's response to the interview question:

> "Yeah! I guess they are. But sometimes, you find that maybe because of certain reasons, they look as if they're not. Especially because, okay, as for today, I was giving them feedback. So, for some of them, they didn't do well. So, it's possible that maybe that can have some negative effect."

The low scores and the teacher's comments in the assignment, possibly made the disappointed students do all they could to avoid poor performance in their future chemistry assignments –"the law of effect" (McCown et.al., 1996). The law of effect, under optimum conditioning, states that a response is more likely to occur, if it results in a satisfactory state of affairs, but less likely to occur if it results in an annoying state of affairs. It is the reinforcement, the scores and the teacher's comments this time, which determine whether the behaviour is more likely to recur (happen again) or less likely to recur. Reinforcement increases the probability that a certain behaviour is repeated – "the principle of contingency" (Louw & Edwards, 2010).

For those chemistry students that did well in the assignment, their good scores and the teacher's comments encouraged them to do even better, and they were therefore motivated; but those who had performed poorly, were disheartened. As Staddon and Niv (2011) put it, operant conditioning is about decision making. In addition to the students having had to select good actions to influence the environment to their benefit, their teacher also had to create a positive attitudinal learning climate (Aspey & Roebuck, 1975). "The law of effect" together with reinforcement, are used by teachers to encourage behaviour that supports learning, and to discourage behaviour that undermines learning.

In two subsequent interviews, the chemistry teacher gave the following responses when asked the same question- if his students were motivated to learn chemistry:

> "Yes, I believe so."
>
> "Yes, they're motivated! Because when they're in class, they contribute, and they also ask questions."

The second abstract strengthens the teacher's belief observed in the first abstract. The students were learning actively, answering and asking questions during lessons. To avoid disappointing such students, their teachers should then provide useful information to the students' information-seeking questions (Nuthall et al., 2012).

During the motivation phase, when asked the same question, this is what the chemistry teacher contributed in two subsequent interviews:

> "Yes, they are motivated, because when they're in class, they contribute, and they also ask questions."
>
> "Yes! They're even more motivated, because when they scramble for, or if there is a question, there is competition to answer that question."

From the two abstracts, the teacher had no doubt about the motivation of his students to learn chemistry. Unlike during the first phase, where he was using expressions such as "I believe" and "I guess they are". In the second abstract, the teacher said the students were even more motivated, and that there was even competition to answer the teacher's questions! This is evidence that the "motivational method" encouraged the students to take part actively in learning chemistry.

When probed about the students that were then competing, (something which was not there previously), the teacher said:

> “Yeah, it wasn’t the case, before. You find that it was those individuals that were now partaking.”

The teacher confirmed that during the pre-motivation phase, only a few individuals were active during chemistry lessons. But during the motivation phase, all the students were active during learning. When asked what motivated the students to learn chemistry, the teacher responded like this:

> “I guess it’s hard to predict, but perhaps it’s the nature of the subject. Sometimes, you find that when we are doing some experiments and other such things, you may find that they are interested in participating.”

Practical activities stimulate most science students, and the teacher could be correct. So, the chemistry teacher did not attribute the motivation to “the motivation method”, but to his teaching methods. Indeed, students like Mlungisi were impressed by the experiments carried out to prove/demonstrate certain concepts. During the last interview with the chemistry teacher, he admitted that the “motivational method” improved the students’ contributions during lessons. The following abstract illustrates that:

> “In terms of cooperation and in terms of contributions in class, they’re doing quite well.”

The “motivation method” did not help only with motivation, but also with classroom management. The chemistry teacher mentioned that his students improved, even in matters of behaviour and cooperation. A student would lose his/her 0.5 marks because of behaviour. Therefore, they all tried to retain their marks by behaving well, and contributing positively during chemistry lessons. When asked if the “motivational method” had helped the students- in terms of knowledge and understanding-, the teacher agreed that the method had helped the students a lot.

On the first interview with the physics teacher, this is what he said about the motivation of his students:

> “Well, as for the general outlook on the behaviour in class, I would say that there is a lack of motivation for the subject. I don’t know whether it comes from previous classes not basically highlighting what physics is all about. But yes, I can say that, in general, they do not show any enthusiasm towards the subject.”

From this transcript, it seems the teacher was not satisfied with the behaviour of the students. They lacked motivation for physics. In the last sentence, the teacher even exaggerated and said “....in general, they do not show ANY enthusiasm towards the subject.”

Lesson observations also partly agreed with the teacher; most of the students seemed to care less about the subject. Late coming and dodging were also observed. To the teacher, it seemed some of the students never knew the importance of physics, or they just did not see their future in physics. Of course, there was a time during the pre-motivation phase, where the researcher had asked Tiny if she saw her future in physics and she’d said “Ah! No!”

Teaching an unmotivated group, could be a huge challenge to both the students and their teacher. This is because learning itself is goal-oriented. So, if someone has no goal to achieve, then they will not learn, nor have the enthusiasm to learn. According to the “achievement motivation theory”, some of the students lacked the motivation to achieve and to experience levels of aspiration (Brennen, 2012). But thanks to some students like Fortune, who actually enjoyed physics, it kept the physics lessons alive.

In a second interview with the physics teacher, he mentioned the issue of attitude being the problem. The following abstract gives the teacher’s response:

> “My students, at the moment, I can say that they have little or no motivation for the subject. I think the problem is that they have an attitude towards the subject that it is difficult, and that they will definitely fail it, even if they do try.”

According to the teacher, it seems the students experienced some difficulties in physics, and instead of working hard to overcome those challenges, they'd decided to give up. Their teacher thought that they had already accepted that even if they would try to work hard, they would definitely fail. So, the group needed to be motivated by the teacher. When probed about what was causing the difficulties in physics, the teacher responded in the following manner:

> "It is not that the subject is difficult, but it's the attitudes of the students towards the subject. The way that I see it ,they have already told themselves that physics is hard, and that there is no way that they can pass it, even though there are quite a number of students in the class that have the potential to do very well in the subject. But they themselves don't feel they can do very well; even though I can see that some have the potential."

In this abstract, the teacher again brings up the issue of students' attitudes towards physics as the main problem, not the difficulty of the subject. McCown et al. (1996) define 'attitude' as a personal feeling or belief that influences a student's tendency to act in a particular way. On the other hand, Louw and Edwards (2010) define 'attitude' as a general feeling or evaluation a person has towards self, others, objects or events. Both definitions of 'attitude 'were adopted for use in this research. As for Tiny (physics student), she had evaluated herself, and had developed that personal feeling that maths and her were like oil and water. The same applied to Daluthando, who also said that her main problem in physics were the calculations. The theory part was fine.

So, the two girls had developed negative attitudes towards calculations, be they in mathematics, physics, and chemistry or in any other school subject. They had generalised (Louw & Edwards, 2010) their hatred for mathematics, to anything to do with calculations. It seemed their physics teacher now had the task of teaching them to discriminate (ibid.) between mathematics calculations and applied calculations (as in physics), and also, to train them to believe in themselves that they could indeed excel in physics. The teacher could spot quite a number of students with the potential to pass the subject – latent learning (Louw & Edwards, 2010).

After introducing the “motivation method”, the teacher noticed little motivation among his students. Here is an abstract for his response to the question asked if his students were motivated to learn physics:

> “Well, since the introduction of the extra credit towards the CA, they are showing a slight increase or added interest in the subject. I guess they are now motivated by that boost in the CA, from those extra points for answering questions in class.”

“CA” stood for “continuous assessment” – a system of recording all assessed student academic work with the exception of examinations.

The physics group was indeed a hard nut to crack. Here is what their teacher said during a second interview of the motivation phase:

> “My students are a difficult bunch, but currently I can say that the motivation for them is low. They are not really that motivated. Even though various methods have been attempted to create that sense of liking the subject, so far it’s not working well.”

When probed about what the problem could have been, the teacher quickly pointed out the attitude the group had towards the subject:

> “The clearest thing that I can notice is the attitude towards the subject. Some of the students have already accepted that they cannot do it. I think that is the first point where we need to try and fix things.”

So, according to the teacher, attitude continued to be the main culprit for the bad performance of the students in physics. During a third interview, the situation of the students had not changed much, according to their teacher. He had announced some work prior and then given them the work; but unsurprisingly to him, their performance was not satisfactory. The following abstract illustrates the situation:

> “From the last assessment I can say that there was no improvement at all. The results of the work did not reflect any improvement from the last assessment that I made of the class.”

When asked about the cause for no improvement the teacher responded thus:

> “I think in this particular case the cause would simply be that they were not prepared. Lack of preparation also shows that there is very little motivation for the subject; and they don’t give themselves the chance to prepare.”

Of course, lack of preparation could be a sign of poor motivation. A negative attitude would cause a student to lose interest in preparing for an announced piece of school work. However, not all the students had negative attitudes. Students like Fortune liked physics and contributed positively during lessons. It was just that the teacher generalized the negative attitudes of the majority of the students to the whole class.

In our final interview the teacher was asked if the motivation method had prepared his students for the test he had just finished marking. His response was to the effect that the method had helped the group. The following abstracts reveal that:

> “I’d say it did slightly help them since there was an improvement in the marks. So, they did see the need to improve in their test scores.”

Improvement in the test scores, though their teacher complained about their negative attitudes during learning, meant there was improvement in understanding – latent learning. It was just that the improvement in learning did not show up in behaviour to be noticed by their teacher. When the physics teacher was asked how the motivation method could be improved for the betterment of the students, he said:

> “At this point all I can say is that the students would need to understand how this particular tool is helping them in terms of improving their marks. I think once that part is clear to them

> I think for now it is fine. It doesn't need any improvement. It just has to come from the students now, to want to actually utilize the situation."

The motivation method was to offer external motivation. The students had to embrace it so that they could benefit from it. So, it seemed the benefit of the tool was not quite clear to some of the students. They behaved as if they did not understand how it worked. Their teacher when probed about this lack of understanding said:

> "Yes, they haven't realized or it seems they can't see how beneficial this particular tool can be to them."

The students' behaviour was uncalled for as the research, plus the motivation method, was explained to them fully right from the beginning.

Interview question: Are you happy about the way chemistry/physics is taught?

All the students interviewed expressed their happiness about how physical science (either chemistry or physics) was taught to them. Included here for analysis are responses of those students who commented more than saying they were just happy about how the subject was taught. Here is an abstract from Tiny during the pre-motivation phase when asked the question:

> "Yeah! It is fair. It's just that maths and me, it's something else."

In this abstract, Tiny still puts the blame for poor performance on the mathematical component of physics. Unfortunately, physics and mathematics cannot be separated because every concept in physics has to be quantified. A solution for her could have been for her to appreciate mathematics and physics and do lots of practice questions in the subjects with her more capable peers. In that way her capable peers would move her from her lack of understanding to understanding the concepts of mathematics in physics.

Goodwill also elaborated a bit when asked if she was happy about the way chemistry was taught. She said:

> "Yes, I'm happy. It's just that sometimes I feel a little bit confused because when we get to go into the deep stuff of chemistry, confusion comes."

Goodwill was happy about the way chemistry was taught despite the confusion she experienced at times. This means her teacher was not able to teach in a way that she could understand the concepts, so, moments of confusion engulfed her. Sometimes ore capable peers can be useful during times of learning confusion. They can provide assistance through explaining the concepts in a peer to peer manner that the student can understand (Coffey, 2008). Social constructivists believe social interactions are the basis for cognitive growth (Vygotsky, 1978).

During his first interview in phase one of data collection, Nkhosinathi responded like this to the question:

> "I'm happy sir since you have to focus."

From this abstract and another abstract from the first question on motivation one can predict that Nkhosinathi was a visual learner. In his responses during the first question he kept emphasizing the issue of concentrating to the teacher during lessons. Even in the present abstract he says students need to focus during lessons. Moreover, during lesson observations he would be seen taking up a front position. The front position is favourable to visual learners so that they can see the teacher's body language and facial expressions to understand the content of the lesson fully (Duckett & Tartakowski, 2014).

During the motivation phase Goodwill responded to the question by giving teaching strategies her chemistry teacher used with them. The following abstract illustrates this:

> "Yes, I'm happy because in our class our teacher makes things very easy. He talks and at the same time he gives us notes to refer to if we didn't understand in class, to study at home. He also gives us practice questions to write as our assignment."

Goodwill's chemistry teacher tried to cater to his students' different learning styles by applying a variety of teaching strategies. Practice questions are indeed good for students, so that they can master the concepts. In a subsequent interview Goodwill made a suggestion which she thought could help them as physical science students. Here is an abstract of that interview:

> "Yes I'm happy. However, I would welcome the opportunity for our teacher to provide us with a simplified book, which consists of only chemistry stuff. One may get lazy and not read the physical science book because it is a big book. It would help us if we could get a simple book with practice questions."

Their physical science book was a thick copy, as it contained both chemistry and physics topics, with worked examples and practice questions. A chemistry book could be thinner than the physical science book and more portable. Goodwill also requested that the language be simplified to make the book user-friendly to students. Simplified textbooks motivate students to read more and result in better understanding of the course. Then both their interest in the subject and their performance improves.

Again, during the motivation phase Goodwill gave informative responses when asked how the subject was taught when she was probed more. Here is her response to the question:

> "So far the teacher is teaching well, because he gives us time to study, to ask questions, to write classwork, homework and quizzes."

Giving the students time for the different academic activities is very important, especially by teachers at school. This is because some of the students do not get such opportunities at their homes. Others do but fail to allocate their time well to their duties – time management. Effective time management enables people to improve, be more productive, as well as be individually fulfilled (Chapman, 2014). A teacher also needs to allow students enough time to think out a response to a question asked.

When asked if she enjoyed all those pieces of work their teacher gave them time to do, she said:

> "Yes. I always enjoy pieces of work because they help me to master the information more and more."

Indeed nothing says it better than the English proverb 'Practice makes perfect'. When probed if she believed in more practice, Goodwill responded:

> "Yes, especially when you're doing the work alone, not copying from others. You're able to see your difficulties and you ask."

Goodwill mentions a crucial matter; that of students who copy answers from other students and submit it as their own just to impress the teacher, or to escape punishment. Copying does not benefit such students academically. Goodwill also mentions the important issue of a student realizing their challenges in certain concepts and then asking for assistance (ZPD according to Vygotsky, 1978).

When probed further about work given by the teacher, if she thought it was helpful to her, and if she did not run away from such work she said:

> "Yes, I don't run away even if I feel that those questions are too difficult. I keep on trying repeatedly because I know when I submit my answers the teacher will help me by giving me the correct answers or giving me the guide on how to answer such questions."

Indeed, this chemistry teacher was playing the role of a facilitator of learning. He would guide his students from what they had mastered to what they could do with the assistance of a more capable person. They progressed to a level where they could do the tasks independently. This made Goodwill persevere even when the road got rough. She did not give up but kept trying.

Mlungisi was impressed by the experiments the teacher organized for them. The following abstract illustrates that:

> "Some of the time sir we learn things practically. We do the experiment, a true experiment and observe it. So, that's why I like the way it is taught."

It seems Mlungisi would grow up to be a true scientist since he expressed his belief in practical things. Having preference for hands-on activities is usually a sign of being a tactile learner (Duckett & Tartakowski, 2014).

Nkhosinathi observed that their teacher was giving them individual attention. Here is a transcript of what he said:

> "I'm happy because the teacher gives us special attention when we don't understand."

Daluthando maintained her complaint about calculations even when asked how she felt about the way physics was taught. Here is her response:

> "Sometimes I'm happy."

When she was asked about what made her happy at times, she responded this way:

> "When the teacher is just teaching without calculations."

Then when she was probed about losing interest once calculations were involved; she said:

> "Yes, I lose interest because it is difficult when it comes to calculations."

So, Daluthando had developed a permanent fear of any mathematical calculations. She had generalized that fear of calculations even to other subjects such as physical science. Generalization is beneficial when it makes one avoid harmful situations, but not when it makes one avoid even beneficial activities such as learning sciences (Louw & Edwards, 2010).

Question three: Should this motivation method used with you be adopted by other teachers? Why?

When Goodwill was asked this question her response was:

> "Yes, it is a very good way of motivating us as students because if I ask a relevant question about the topic that we are discussing today, I know that I'm going to get a mark. The teacher is going to reward me with a mark, so that makes my CA."

According to Goodwill the motivation method was really motivating them to engage actively in science lessons. When asked if teachers of other subjects could adopt the method, she agreed that they could adopt it and she recommended mathematics as the first subject. During a second interview with her she elaborated:

> "I think this motivation method is very good for us. It makes one concentrate, and come to class on time because I want the teacher to reward me this 0.5. It makes one do the homework, because I want to get the mark. And I want the teacher to see me as a very good student. It also helps one concentrate a lot or ask a question. If you don't understand, ask: 'Sir, what is this? What is that?' If you ask a relevant question, you get your 0.5. So, it is nice that my marks; my CA, is improved. Yes. I think other teachers can adopt it. You can say no, this 0.5 is too small. But it is very very important and very useful, because if you say 0.5 plus a 0.5, that is a mark. Yes, it does make a difference. Yes."

According to Goodwill, the motivation method improved the students' learning by increasing their concentration, and the likelihood of them asking and answering questions during lesson time. It also enhanced punctuality, and demonstration of good behaviour towards their peers in the classroom. When asked if she really thought other teachers could adopt it, she said:

> "It will be my pleasure Sir. It will benefit their students a lot. Our teachers used to tell us that if we misbehave in class, they will withdraw your 0.5. So, you're always in a spirit that I don't want my 0.5 to be taken because it will help me. And it (motivational method) does boost us because if you get 48% marks, with your 0.5 you might get 50% and then you have passed your subject. A very useful method and it is motivating us a lot. Yes."

When questioned about the possibility that it increased liveliness in class, she had this to say:

> "More than before. There is life because everybody wants to concentrate and ask where he or she doesn't understand. Because I know when I ask the teacher will reward me. No one is shy now because these marks are very important. Everyone wants to pass."

During the last interview with Goodwill, she gave another detailed account about the usefulness of the motivation method:

> "Yes. I think other teachers should adopt it. If you are looking at it - this motivation thing - you can say no, this is a game. How is 0.5 going to help me? It is not even a mark, 0.5, but when you say 0.5 plus another 0.5 that gives you a mark; which can boost your CA. It motivates us because when a teacher is teaching, you get to listen because 'I want to ask a question'. If I ask a relevant question, I'll get a 0.5. That boosts my CA. That adds some marks to my work, and you come to be straight and listen. You become obedient because if you disobey in class the teacher will just withdraw your 0.5. That means you lose a mark again. So, it makes one concentrate, keep quiet, and ask a question that is important or relevant. Yes it is a very good method."

When asked to give examples of subjects in which students could benefit with use of the motivation tool, Goodwill said:

> "Maths and physics. Many students take these two subjects as if they are very difficult subjects. So, many students have got this negative mind or negative attitude towards the subject. So, if this motivation of 0.5 can be introduced, a student will be able to listen in class or to do the homework, or even ask the teacher a question because he or she knows that they will be rewarded a 0.5 mark. And in physics we deal with formulas most of the time. So, for example if the teacher asks the formula of acceleration, if a student knows that formula, you simply raise up your hand, the teacher points to you, you say the correct formula, you get a 0.5. That adds some marks to your CA."

The issue of maths and physics being considered as very difficult subjects by many students was brought forward by Goodwill. She claimed that many students had negative attitudes towards those two subjects. The motivation method made work easy for the teacher when it came to classroom management. The students were self-disciplined – they showed self-regulated behaviour. Bandura (1986) claims that self-regulated behaviour is central to learning. So, when asked if Goodwill really thought teachers of other subjects should adopt the method, she agreed:

> "They should adopt it. It is very motivational and it causes us to come to class in time because you know that if I don't come in class in time the teacher will take my 0.5 and then my marks are decreasing. If I come on time I listen to the teacher, I ask questions, I write my work. I know my teacher will reward me the 0.5. Yes, it is very motivating Sir. And it even helps many students keep quiet and stop making noise because no one wants to lose marks. There is order, punctuality and focus."

When Mlungisi was asked the same question, he agreed that other teachers could adopt it because it was helpful. Biology and geography were the subjects he thought could adopt and use the method. His reason was:

> "Let me make an example of this geography. So, I don't know in other schools but in this school, sometimes we don't do practicals but they tell us that there is this, or that is like this. So, they don't do it practically in front of us."

According to him, their chemistry teacher was doing more practical work with them even before the motivation method was introduced, which made him understand the subject better. Practical work motivated the students in the subjects and simplified abstract information for them. So, he thought if the biology and geography teachers could adopt the method, then they could also do practical work with them, making it easier for them to understand those subjects. During a second interview with Mlungisi he returned to the issue of practical work, which he said made it easier for students to grasp concepts:

> "Yes Sir, more, especially in geography. So, there are many practical things in geography but we don't do them practically like in chemistry. We don't do any experiments. Let me give an example. When we are learning about a river, they never even go there and measure the actual thing."

When Nkhosinathi was asked this question, he was brief in his response:

> "They can adopt it and use it because it keeps students self-motivated during lessons."

When asked how he felt about it, he said:

> "I'm happy about it. I get motivated."

Even during a second interview of the motivation phase, his response was concise:

> "(Sigh) The motivational method of awarding marks helps a lot because it boosts the morale of students."

Nkhosinathi's contribution to this study, with regards to the "morale boosting", summarises several aspects according to the students. The motivation method boosts their attitudes and also helps students behave well. Nkhosinathi thinks biology, English, geography and maths teachers should to use the motivation method with their students. During the last interview with Nkhosinathi, he recommended the method for the whole school so that its results would be better at the end of the year.

When Fortune (a physics student) was asked about the motivation method, he responded in the following manner:

> "Yeah! I think it is the best motivation. Other teachers should use it."

When asked why, he said:

> "As for me, I easily understand the way the teacher provides the information to us students."

When asked how he thought the motivation method could be improved, Fortune said:

> "I think maybe if we can work in groups, our results can be improved, and if we can have more practice in this subject."

Unlike in chemistry where Mlungisi said they were doing experiments, in physics there were no experiments. Experiments are good in that they help students master science process skills, especially integrated skills (Brotherton & Preece, 1995). Fortune expressed his preference to work in groups, for it is in such set-ups that students help each other and also develop many social skills.

Students engaging in collaborative strategies such as peer tutoring develop positive attitudes towards learning and develop self-confidence (Thompson, 2013). Students like Daluthando and Tiny had developed negative attitudes towards calculations, and even generalised and exhibited that similar behaviour towards other subjects that involved mathematical calculations, like physics.

When Fortune was asked the same question during a third interview, he simply said:

> "As for me, I see it as the best way of teaching the subject."

When asked about other subjects that could benefit from the motivation method, Fortune mentioned chemistry and mathematics.

Daluthando also agreed with the other participants of this study regarding the benefits of the motivation method, and how teachers of other subjects should adopt it. The following extracts from different interviews with Daluthando illustrate this:

> "Yes, I impartially recommend it because it helps us as students to keep improving in the subject."
>
> "Yes, they should adopt the method because it makes us put extra effort and to improve in the subject."
>
> "Yes, they should adopt it and use it because it is very helpful. We as students improve from it and it improves the way the teacher is teaching. We understand better than previously."
>
> "Yes, they should adopt this method because as students we're not all good in learning; but once they use other methods of teaching we do understand better."

Daluthando's interview extracts reveal that the motivation method helped students improve in physics. They even understood the subject better than before the motivation method was introduced. According to her, the method enriched the teacher's teaching methods. It also encouraged students to put more effort into their learning; a sign of developing self-regulated behaviour.

When asked about other subjects that could benefit from the motivation method Daluthando mentioned agriculture, chemistry, geography, history and mathematics. All these subjects involve mathematical calculations except history. So, the method could improve student performance in subjects that did not involve mathematical calculations. This means that all teachers could adopt the method and use it with their students as a motivational tool.

Tiny, too, recommended the adoption of this method by teachers. Here is an abstract of the first interview held with her during the motivation phase:

> "Yes, I think they should adopt it coz (sic) some of us have real difficulties in more subjects not necessarily physics only; like maybe maths. We also need that in maths coz (sic) we really have low marks."

Tiny saw the motivation method as a solution to learning difficulties and low marks. In a second interview she mentioned how the method helped them gain more marks:

> "Yes I can recommend it to other subject teachers coz (sic) it makes us talk more and obviously then we get more marks if we talk more."

During the interview, Tiny also added that since the introduction of the motivation method she was concentrating more in class than before. During the last interview with her, she mentioned why she thought other teachers should adopt the method:

> "Yes, I recommend it to other subject teachers because it's not like we all have difficulties in physics, there are other subjects which some other students find difficult. I guess then it can also help."

When asked how she thought the method could be improved she said:

> "I guess the 0.5 is a bit small. If it could be one or maybe more than one."

The chemistry teacher also recommended the motivation method for use by other teachers. He put it in this way:

> "Yes I would, but I was also thinking of using it with my other classes. It's just that I've only two classes now. But I was thinking of using it and see how it works with other students. But I guess it will be perfectly well."

So, the method is working well for this teacher since he is thinking of using it in more of his classes. When the teacher was asked if the method helped the students or him, he said:

> "Yes it does help the teacher because there is now less disciplinary work whereby you're trying to control the students and all the like. So, when you come to class you find that they will rush to clean the board and everything is in place and everything goes well."

From this extract, it can be deduced that the motivation method seems to benefit both the teacher and the students, since good classroom management supports the teaching/learning process. The chemistry teacher also thought the method could change the results of the school; something Nkosinathi had also noted:

> "Yes, I would recommend the method. I guess it can change even the results of the school. It can have a positive impact on the results."

In the last interview with the chemistry teacher, he recommended the motivation method for the cooperation he was receiving from his students during its use:

> "Yes, I guess it will work perfectly well because for me it's like a blessing because you find that you do not stress yourself. You know that the pupils are going to cooperate as you teach because they are more than eager to partake in the lesson."

It seems the motivation method helped prepare a more conducive teaching/learning environment for everyone (teachers and students). Students that are always ready to learn are usually a marvel to teach and they cooperate in every way possible. When the physics teacher was interviewed and asked if he would recommend the motivation method to other teachers, he agreed:

> "Yes, this for me is very effective. So, I'll definitely recommend this particular method to other subject teachers. I direct this to the sciences since more students have got that

> attitude of not wanting to participate in class, especially in the sciences. This particular method is very effective for me because now it forces some of them to actually engage because they want to get those extra marks."

The motivation method was working even for a difficult group like those physics students. Their teacher observed that the method was forcing some of them to engage in class so they could improve their marks. Engaging in lessons helped the students to concentrate on what their teacher was saying and to understand new concepts:

> "Engaging in lessons helps students to conceptualise class discussions rather than to just sit back and to let me do all the work. This information tells me there is a little difference in terms of participation."

The students were slowly taking ownership of their learning. During a second interview, the physics teacher said he thought the motivation method would be effective once the students got used to it:

> "In my view, teachers of other subjects can adopt the method for the simple reason that the students will want to earn extra marks. At any rate, students will try to at least earn a few extra marks. I think that the method will be effective. Once they (both students and teachers) are used to it, it will be an effective tool."

The teacher thought students should participate more in lessons that would motivate them to understand the subject:

> "Yes, I would still recommend the method because it encourages the students to participate. I think when they want to participate; students will also want to gain a better understanding of the subject."

During a third interview, the physics teacher explained that other teachers could adopt the method because it had inspired the students to participate more in lessons. It had also indirectly motivated students to learn the subject. Here is an abstract to illustrate this point:

> "Yes, I'd very much recommend the motivation method. It will engage students and will prompt them to participate in class discussions to get extra credit. As a result of this method, students may begin to like the subject. For those students who have tried to engage in discussions, I have seen an improvement in their marks. But I haven't really measured whether the change is simply because students are just getting better in the subject, or if it's because the year is almost over so students want to improve their marks."

For those students who had engaged actively in the lessons, the teacher observed improvement in test scores, a result which can be attributed to improved understanding of the subject. When the teacher was asked about other methods that he thought could foster his students' success, he recommended a practical approach to teaching physics:

> "As a new teacher, I would say that for now I need a practical approach to teach the subject. I think this approach will decrease the fear of the subject in some students because I can relate the concepts such as levers and moments to everyday life. For instance, I told my students that opening a door is a typical example of a moment and that the arm is an example of a lever, so they basically spend their life practising physics. From what I'm seeing, students just come to physics class having accepted that they will fail, so they don't even try."

A practical approach to teaching the sciences helps students to make sense of abstract information. Though students in high school are in the formal operations stage of cognitive development, they do at times regress to the concrete operations stage (McCown et al., 1996). This regression is common when students find information difficult to imagine or to understand; a concrete example then comes in handy. The best experiment or practical is one in which the students are involved, as opposed to a demonstration by the teacher.

The students' coming to physics class assuming failure is a sign of helplessness and a lack of hope. Natural science teachers need to discourage students and parents from viewing the sciences as difficult or impossible subjects. Once this negative stigma is removed, students will no longer fear the sciences. Teachers were then asked about the effectiveness of the motivation method:

Question: How has the motivation method contributed to students' discussions, understanding and performance?

In one of the interviews for the second phase, the chemistry teacher responded as follows:

> "The method has improved how students listen in class because I find that they are more attentive. They are awarded some marks for correct answers or responses, so students make sure to provide correct responses. Even if a question calls for calculations, I find that students try to calculate the answer before their classmates do, so the students are learning at a faster rate."

The motivation method seems to have improved the nature of the chemistry lessons. The teacher noted improvements in the students' attentiveness, the number of correct answers and the assignment-completion rate. When probed about his students' progress, the chemistry teacher agreed that "it has improved a great deal."

In another interview, the chemistry teacher said:

> "Yeah! The motivation method has contributed a lot. I find that I do not even need to ask them some questions. Students are ready to answer anything I ask. Even if I write a question on the chalkboard, I find that they are figuring out the answer without my having to ask. When I turn around, I see students ready with an answer."

The students were trying to do well. The physics teacher also noted some positive effects on the teaching and the learning process:

> "The method has really encouraged students to communicate and to participate in class. I can say that it has really motivated the students to be active and to engage in class

discussions. The method is working. There is improved understanding of subject matter. Students now, because of that extra credit, actually attend my lessons."

When asked if the students' behaviour had improved, the teacher said:

> "Not that much. There are still some students that from time to time will want to avoid coming to class, and there are those students who make a habit of deliberately not coming to class. But, generally, some of them are showing a slight improvement."

In another interview, the physics teacher mentioned that his students had started asking and answering questions in class:

> "The motivational instrument we're using does help. The students do try now, even if their answers are not well thought out. But because of that extra mark, they are trying to engage or to have that engagement with me as their teacher."

The physics teacher noted that participation in lesson activities, not understanding of lessons, had improved:

> "I think that the participation increased a bit. Performance was more or less the same."

The teacher agreed that participating in discussions did help the students:

> "Looking at the topics from the last few lessons, I will say that participating in class discussions has helped students to retain information. Students remember the material they learned when I introduced the topic. There was just a slight improvement in terms of answering questions."

The physical science teachers were asked how they motivated their students:

Question: Do you motivate your students to talk in class? What strategies do you employ?

The chemistry teacher said he motivated his students, especially at the beginning of the lesson. He claimed to use the question-and-answer method. He posed questions to the class and waited for students to respond. If students did not respond, he rephrased the questions. If he still didn't receive a response, then he purposely pointed to the students he knew would provide an answer:

> I pose questions, and I expect students to answer. If students don't answer, then I rephrase the questions. If there are still no responses, I try to incite discussion by pointing at the students I believe will give me an answer."

The physics teacher motivated his students too:

> "Yes, I do motivate them. I once went to that discovery learning workshop in which I determined how to interact with the class. I don't give away all the answers to whatever I'm teaching the students. The students have to actually discover what I am driving towards, so I would say that I do motivate students to discuss a particular topic. I do ask if anyone has figured out the answer before I share it."

The teacher discussed discovery learning, a method one of his students had mentioned. Discovery learning inspires students to engage in the subject matter and helps them to develop all the science process skills, even the advanced ones (integrated skills). Here is another abstract in which the teacher explains how he motivates his students:

> "When I see that students are reluctant to learn physics, I do encourage them to participate so that there is a link between me and the class."This participation will make sure other students can see that physics is indeed an understandable subject. If one student is able to answer the questions, others will be motivated to answer questions as well."

According to the abstract, the teacher tried to establish a rapport with his students, a method which creates a good atmosphere for teaching and for learning. He motivated his students by outlining the subject in detail and by working through problems on the chalkboard so students could learn to solve the problems too.

According to what the physical science teachers said during the interviews for the pre-motivation phase, teachers were motivating their science students to engage actively in lessons. However, in the final phase of the study, their students were not motivated to learn physical science —a goal this study wanted to accomplish.

4.2.1.1.2 Talk

Student participation was one of the themes that emerged from the interview data. Here are the three questions regarding class participation that students were asked:

1. How frequently do you talk during chemistry or physics lessons? Never. Rarely. Often. Always.
2. When do you talk during chemistry or physics lessons? When you're asking questions, answering the teacher's questions or only when prompted by the teacher?
3. Is talking in class helpful? Give reasons.

During the motivation phase, teachers were asked:

Question: How often do your students talk during chemistry or physics lessons?

Daluthando said she talked in class only when her physics teacher asked her questions. When asked if talking in class was really helpful, Daluthando said:

> "Yes, it is helpful because I find that when I write a test, I try to remember the answers I have said in class."

Daluthando, a student, explained that talking during lessons helped her to recall answers. According to Tanner (2009), talking enables students to process information. However, the challenge Daluthando faced was that she only contributed to her science lessons by answering the teacher's questions; but did not ask questions in return. Daluthando expressed that she never asked questions in class because she feared her teachers. In another interview Daluthando mentioned the importance of talking in class. She stated

> "Talking in class is part of communication when you're learning as a student. So, talking in class is very very important. It leads us to pass."

Subsequently, Daluthando knew that good communication in the classroom lead to academic success even though she never fully engaged in class. When Daluthando was asked during the motivation segment why she did not speak during her physics lessons she responded that she preferred to write rather than talk in class. She explained:

> "Sometimes I feel like it is better to write down than talking, according to my own understanding."

When Daluthando was probed about teachers giving more notes and talking less, she said she would prefer it that way. From Deluthando's statement, one may guess her learning style would be that of a visual learner since she preferred detailed notes on the chalkboard over explanations. Even though Daluthando knew the benefits of talking during lessons, her reason for not talking was out of her fear of being laughed at by her friends. She illustrated:

> "Keeping quiet does not help me because if I talk to the class, I will remember the answer I have said in class, just because of fear of the students I don't talk. They may laugh at me when I say the wrong answer."

Tiny too behaved like Daluthando in class when asked questions by her science teacher, but she also knew the importance of talking in class. She explained

> “If maybe I make a mistake in class, maybe the teacher corrects me, and then I get to know that.”

> “Because you get to learn if you don’t know something. But sometimes it is not helpful because you can talk and talk and talk. In fact, writing is better than talking.”

The next abstract followed her response to a question she was asked if talking was helpful. Her response was:

> “Somewhere it is helpful and somehow it is not.”

In a subsequent interview Tiny felt talking during science lessons was not helpful. Her argument was:

> “Because the following time I’ll forget whatever the teacher said. Instead writing is better than talking.”

According to Tiny, writing was more effective than talking; it helped her to remember what she was learning. But during Tiny’s last interview during the first data collection phase, she mentioned that she often talked in class when she was answering the teacher’s questions. When asked why she never asked her teacher questions she said:

> “I’m afraid. I’m shy.”

When Tiny was asked who she was shy of she said

> “Of the other students.”

When asked why she was afraid of the other students she said

> “I’m just scared of talking in the mist of many people. Like, they imitate me the way I talk.”

When asked if they liked the way she talked she responded by saying

> "They just make fun of it. To them it sounds unique. To me it is not."

Students were impressed by Tiny's handling of the English language and the way she pronounced her words. When she was asked if talking was helpful, she stuck to her idea that it was not

> "Talking? If we talk today the following day I might forget whatever we said yesterday. I prefer writing instead of talking."

Tiny, and perhaps other students like Daluthando perhaps do not realise that both talking and writing are important during the teaching and learning process. Therefore, teachers and students need to find a balance between these two activities. Writing and talking help with the cognitive processing of information (Louw & Edwards, 2009).

In our first interview during the motivation phase Tiny seemed to have changed her idea of disapproving talking in class. She had started seeing the usefulness of talking during science lessons. She states,

> "It is helpful coz if I get something wrong and the students laugh at me, by the time the teacher corrects that it will be stored in the long-term memory."

According to Tiny the benefit of talking in class is when a student is corrected in front of other students, that correction stays in the long-term memory. By the second phase of data collection, Tiny had realised that being shy and afraid of talking in the midst of her colleagues was not going to benefit her. In a second interview Tiny agreed that she talked during physics lessons and that benefitted her. She explained the benefit of talking in class by stating

> "Because once I'm corrected somewhere somehow, I won't easily forget that one."

It appears that the motivation method motivated Tiny to talk during lessons despite the humiliation from the other students about the way she spoke.

The issue behind talking during physics lessons was different for Fortune, he always talked in class. He claimed during the first interview of the pre-motivation stage that he even asked questions during lessons. He explains

> "I always talk Sir when I'm asking questions."

When Fortune was asked how helpful talking was during physics lessons, he said

> "It helps me a lot. Not only me but even the whole class because I understand the most when I ask questions from the teacher."

Fortune noticed that when a student asked the physics teacher questions the other students that feared asking benefitted from this. Students like Tiny and Daluthando benefitted. When Fortune was questioned more about the importance of talking to the teacher after class he said:

> "Au! I'm not used to doing that."

Seemingly, most of the students that took part in this study did not seek help from their science teachers outside of class; only Mlungisi did so. In another interview when Fortune was asked if he talked to his friends during lessons, he said

> "I don't talk to friends because I will disturb the teacher when teaching."

Fortune probably gave the teacher his full attention. When asked how helpful talking was Fortune responded by saying:

> "You understand better when you talk, ask questions and respond to a teacher. You understand better what the teacher is teaching you."

Fortune believed in interactions during lessons for proper learning. He did not believe in asking too many questions while the teacher was right in front of him. He asked questions immediately not only during physics lessons, but also during other subjects. He also asked questions not only for his own understanding but to benefit the other students too:

> "It helps me to understand the lesson the teacher is teaching me, but not only me but the class too benefits while I'm asking some questions from the teacher."

According to Fortune asking gives the teacher more time to explain concepts to students:

> "We students easily understand when we ask what we don't understand and the teacher gets more time to explain, and others understand when we ask."

Mlungisi was one of those students that claimed during the pre-motivation phase that students never talked during chemistry lessons. He mentioned fear of embarrassment as his reason for not talking:

> "I never used to talk in class."

> "I'm afraid of embarrassment just in case my answer is wrong. So, the other students may laugh. So, I'm afraid."

When asked if laughing at each other was beneficial, Mlungisi said:

> "No! It is not beneficial. No, it is not."

When Mlungisi was asked about the reason for laughing at each other he said:

> "(Soft laughter) I don't know the main reason for them to laugh."

When asked if he found keeping quiet during lessons important he responded:

> "No, it is not important because sometimes you lose concentration. When you're quiet you may sometimes get outside of the lesson; thinking other things."

Mlungisi was correct; an actively engaging student follows a lesson. Should such a student be left behind then it will be easy for the student to say where exactly the problem is. During a second interview Mlungisi stated another importance of contributing when learning:

> "Because immediately when you say something in class, so when it comes out in a test or in an exam, it will be easy for you to remember it because it was said by you in class."

When Mlungisi was asked how he engaged actively during lessons he said:

> "I listen to others when they talk and try to understand their concern and the teacher's response."

Based on Mlungisi's statement one can conclude that Mlungisi was an example of the type of student Fortune referred to as benefitting from what others contributed in class; students that never talked themselves. Mlungisi was so afraid of asking questions that he used other students around him when he had a question:

> "Being afraid sometimes helps me because I listen to the others when they talk. Sometimes I even use Nkhosinathi to ask for me a question because he sits next to me. So, he asks that question and I listen to the response of the teacher."

When he was asked if he thought Nkhosinathi was not afraid of embarrassment, his response was:

> "Yes, Nkhosinathi is active. So, even if he is wrong (soft laughter) he also laughs when they laugh."

Mlungisi’s biggest challenge was when the others laughed at him he became shy. When asked if being shy benefitted him he stated:

> “No. It does not benefit me but it’s just my nature. I’m afraid to show up.”

Behaviour like Mlungisi’s caused many high school Swazi students to be reserved during science lessons. Mlungisi continued being afraid of asking or answering questions even during the motivation phase. He used Nkhosinathi as a way to contribute in class. In another interview he emphasized on the issue of asking questions using another student such as Nkhosinathi:

> “Yes Sir. It is helpful because when you don’t understand something, and he asks it from the teacher, then you have a clear picture about that.”

By the middle of the motivation phase of data collection Mlungisi revealed that he had started talking among his classmates during experiments. He explained when asked if the motivation method changed the pattern of talking during chemistry lessons by stating:

> “Yes Sir. It has changed the pattern because most of the time, let me make an example, when we’re doing the experiments the teacher divides us into smaller groups. So, it is easy to talk in front of a small number of people. So, even if they laugh, they’re controllable than the whole class. So, I tend to talk when we’re in those smaller groups.”

The smaller groups seemingly encouraged shy students like Mlungisi to develop self-confidence (Hott et al., 2012) to talk among the other students. Student discussion is the central part of many active, innovative, and inquiry-based approaches to teaching (Tanner, 2009). When Mlungisi was asked if the whole class was benefitting from the motivation method he said:

> “Yes Sir. It has also helped the class because even the marks that they get, the lowest and the highest; the range is not that much.”

In conclusion, the motivation method improved the nature of the whole chemistry group. In the last interview when Mlungisi was asked if he thought the class had gained anything from the motivation method, he stated:

> "It has gained a lot because there is great improvement even in the participation in class. Students were able to participate with the teacher. So, it was very easy when the teacher asked a question to raise up their hands and respond quickly to the teacher."

Seemingly, Mlungisi was excluding himself from the students who were encouraged by the motivation method to raise their hands in class. He gained the confidence to talk during group work where there was no need to raise hands before contributing. Goodwill was the opposite of Mlungisi; she always talked in class. When asked about what made her talk in class, she said:

> "When I'm asking a question or answering the teacher's question, I'm not afraid and I ask a lot."

When asked about the importance of talking during chemistry, she responded this way:

> "I want to master the information, Sir, because sometimes I don't get the time to study, but when it comes to tests or an examination, I just recall what the teacher said in class. Talking is helpful because you ask a question when you don't understand and the teacher gives you the answer."

Goodwill believed in mastering information while in class, when being taught, not later when she was by herself. Doing so helped her in tests and exams; she was able to recall the answers she gave in class and those she was given. She also liked it when the teacher gave examples, because during tests and exams it made it easier for her to remember the necessary information. Goodwill would also go beyond asking and answering questions to debating with the teacher during chemistry lessons:

> "Yes, as for me I ask a very lot and sometimes I debate with the teacher. If I just don't get it or if I've learned this thing before maybe in another book I say, "Teacher, no no no." I

> think there is a better way of doing this. And when my way is not a good way the teacher gets to explain it that no, you can do this and that."

When probed about whether or not debating the teacher benefitted her, she said:

> "It benefits me a lot because when I ask the teacher is supposed to give me an example, then I master very well. Yes it's very helpful."

In an interview conducted during the motivation phase, when asked if she talked during chemistry lessons Goodwill gave a loud sigh and said:

> "Oh! I talk a lot. I ask the teacher and argue a lot. Sometimes you can think this student is so disobedient. No! I want to know. I want the teacher to give me a clear example. Yes, to master the thing. If I forget maybe the meaning of the thing, the term, I start to think, to recall the thing, maybe an example, and then the information will just flow again."

Lessons with students like Goodwill are usually very lively and consist of constructive arguments. When probed about the importance and helpfulness of talking in class she responded:

> "It is very important to ask a question if you don't understand. It helps me a lot. Even arguing, because as we are children our performance is not the same and our minds are not the same. Some are average. Some are better than others. You know, we start to argue, the other student will say this, the other student will say that, and then the teacher will explain the correct thing to us. And I enjoy it so much. I value it very much. It is very important to contribute and not just keep quiet."

Goodwill was unlike Mlungisi, who would ask questions through Nkhosinathi. She believed in herself and expressed herself fully during lessons, not through other people but doing so herself. When asked if she did not mind being corrected she said:

> "I don't mind being corrected. I like to laugh. Some students, if you ask them something, laugh. They say "Ah! This one is just asking funny things."And me, I'm being helped so much. And I enjoy it."

Despite the behaviour of the class in laughing at other students, Goodwill found the courage to speak up, realising that talking during lessons benefitted her. In one other interview, she claimed her chemistry teacher could testify that she contributed during lessons:

> "I talk a lot and I ask questions and I debate a lot with the teacher. I like it. Even my chemistry teacher can say that Goodwill is always talking, asking questions."

When probed about her being active during lessons she said:

> "I'm always active and look at the teacher because as soon as I don't I will lose focus. I will just start thinking about other things. I concentrate and it's helpful even to debate because the teacher will come up with another way of solving that particular thing, and as a student you think of something else, and maybe another student is thinking of something. So the solutions are brought together, and then you take the easy way to find that thing."

When asked about brainstorming, she said:

> "Yes, it is good. Not only the ways in the book, but different ways of attempting those questions."

Goodwill believed in knowing as many ways of solving a problem as possible so that she could then choose the easiest.

Nkhosinathi often talked in class, but was the kind of student that believed in keeping quiet for reasons of concentration. When asked if talking during a lesson was helpful, he responded:

> "It depends. Most of the time you have to keep quiet and concentrate. If you concentrate you master more things taught by the teacher."

So, Nkhosinathi would talk when he had questions or when responding to the teacher's questions. When he was again asked if talking in class was helpful he said:

> "Talking is really important, Sir, because it helps when you don't understand some of the things. You have to consult the teacher. We also get different views from different students in class."

During the motivation phase, he mentioned being corrected as a benefit of talking during lessons:

> "It benefits me because when I'm wrong the other students correct me or the teacher corrects me."

When probed further about this, Nkhosinathi said he didn't take being corrected as a bad thing. Maybe that was why Mlungisi always asked questions through Nkhosinathi. According to Mlungisi:

> "When you get a correction you know you shouldn't repeat the same mistake the following day."

When asked if the motivation method prompted him to talk more during class than in the pre-motivation phase, he said yes. When their chemistry teacher was asked how often the students talked in class when compared to phase one, he said:

> "Yeah, it's more often. They are more vocal right now. But the thing is, the talking is in two forms. You may find that they are talking, but the talking is not directed to what the teacher wants. But for now even the direction seems quite well, because if someone wants to misbehave they are the ones left cleaning up the mess by their fellow student."

According to the chemistry teacher, his students had improved in their rate of talking in class when compared to the time before they were motivated to talk. Their talk was even directed towards the lessons. Moreover, the students were correcting each other when it came to behaviour. On being asked if talking during chemistry was helping his students, he responded:

> "Yeah! It does, because they are free to discuss things with the teacher. Even if they have something they don't understand they are free to talk. Okay, it's like the environment is very good or suitable for such."

Thus the motivation method presented the students with a positive learning environment. They felt free and welcome to talk to their teacher about chemistry matters. They even competed with one another:

> "...You find that in most cases they are competing to contribute or to try to answer questions, such that when you pose a question you find that they are more than alert to answer that question. Other than the other times where you might be talking and some pupils are busy with other things. They are now more attentive in class."

From this abstract a conclusion was reached that the motivation method indeed had a positive impact on the students. It really motivated the chemistry group to actively engage in their learning. Even the physics group improved in terms of classroom discussion, according to their teacher:

> "The level of communication between the students and myself since introducing that extra credit has improved. Not too much, but it has shown that there is some visible difference in terms of the communication. The linkage is much better between the students and myself. The method has brought improvement in terms of that situation of communication and wanting to participate in class. I can say that the method is working."

The physics teacher also noticed that the motivation method was helping his students engage more in classroom talk than they did before. However, he felt their engagement in classroom talk still wasn't enough:

> "They don't talk that much. In most cases I have to be the one who engages them in order for them to link and communicate with me. Otherwise it gets to a point whereby if they do not understand the concept no one will actually say, "Ei, I cannot understand this." They will just let me carry on. Then I will notice that they haven't heard anything. They'll start to engage once I start back-tracking my lesson from there. The motivational instrument we're using there, it helps. They do try now. Albeit sometimes the answers, the questioning is not well thought through. But because of wanting that extra mark, they are trying to engage with me as their teacher."

When asked if the motivation method helped in terms of talking, understanding, or performance, he said:

> "I think for that one the only aspect it helped was that there was more participation rather than, not necessarily more understanding, but rather the participation increased a bit."

The teacher also noticed improvement in the answering of questions, which he attributed to active engagement in lessons:

> "Looking at the topics from the last few lessons, I will say that it helped in that most of the students managed to remember most of the stuff that we did when the tool was introduced. There was just a slight improvement in terms of answering questions there."

The students themselves said that asking and answering questions in class helped them better retain and recall information than when they learned passively.

> "The motivation instrument we're using there, it helps. They do try now. Albeit sometimes the answers, the questioning is not well thought through. But because of wanting that extra mark, they are trying to engage with me as their teacher."

The physics group seemed to need more time using the motivation instrument, to get used to its usage and benefit fully from its application. Their teacher observed slight improvement:

> "With that new tool that we introduced, the activity, or rather wanting to engage during lessons, improved slightly in that they would gain extra credits. So it did help in a way, during class, during lessons. I think the motivation method only helped in that there was more increased participation."

When probed if the participation in classroom talk helped the students, their teacher said:

> "Looking at the topics from the last few lessons, I will say that it helped in that most of them managed to remember most of the stuff that we did when the tool was introduced. There was just a slight improvement in terms of answering questions there."

From the abstract it is evident that active engagement in classroom talk helps students in better understanding concepts and retaining information for future use.

4.2.1.1.3 Performance

The first question analyzed under performance was:

When given some assignment to do at home, do you submit that work on time? Why/why not?

The first time Daluthando was asked this question, she said she did not submit her work on time. The reason she gave was that she encountered certain difficulties:

> "You find that when I'm given homework to do at home I find some difficulties, which I face, which lead me to come back to the teacher to ask."

Daluthando’s response was contradictory to the one she gave when asked if she ever talked during class. Her response was that in case of difficulties she approached her friends for help, not the teacher. The two responses indicated that, like Mlungisi, Daluthando feared being laughed at in class but did not have problems approaching the teacher privately. In another interview, Daluthando said submission of her work depended on the topic:

> “Yes I submit work on time, but it depends on the topic and if I have understood it.”

When probed further about why she did not submit her work on time, Daluthando said:

> “You find that sometimes the questions are very, very difficult and I come back to school, to the teacher or to my colleagues to seek help. Then when they have given me help I attempt the questions again and submit.”

So, Daluthando was delayed in submitting her work on time due to the difficulty of the questions. But in the end she did submit, after seeking help from teachers and other students rather than copying other students’ work:

> “I never submit incomplete work. As students, it disturbs us if we don’t understand certain questions asked in an assignment. On such occasions, we come to school early morning and copy work from our classmates. I don’t like that.”

Daluthando submitted work she had done herself, not the work she had copied from someone else. That was a good habit and showed she wanted to improve in the subject. On the other hand, Tiny said she did not submit work when she failed to understand a given question or a concept:

> “Sometimes I submit my work and sometimes if I don’t understand a topic, I don’t.”

Tiny never mentioned any efforts she made in case she did not understand some of the questions. She only shared the reasons that held her back from completing her homework:

> "There are several reasons why I fail to complete my work. On certain days I don't have enough time. However, if I am able to read the assignment in time, I might be able to submit it before the deadline. Sometimes I might fall asleep and forget about it altogether. And then there are times when I don't understand the topic at all."

Tiny had three main reasons for not submitting her work on time, including falling asleep, forgetting, and not being able to understand the concepts. During the motivation phase, Tiny did not mention any excuses for failing to submit her assignments. She, however, appreciated the feedback she received from her teacher:

> "I feel I benefit from working on class assignments. When my teacher returns the work I submitted, I understand where I have gone wrong and how I could correct it."

When asked if extra points awarded during the Physics class for participation in class discussions ware boosting her morale, she said:

> "Yes, it has. The more I participate in class discussions, the more points I get. Since I find Physics to be a challenging subject, if I ever score low, the 0.5 points I receive for being part of the discussions will make a huge difference."

During the motivation phase, Tiny said she always submitted her assignments unlike during the pre-motivation phase. One would interpret this punctuality in submission to mean improvement in understanding the subject and enthusiasm to study it more. As for Fortune, he submitted his Physics assignments on time. When asked why he said:

> "Our teacher always requests us to submit the work on time. He wants to know whether we have understood the topic. If we haven't, he tries another way of teaching it."

Indeed, students' written work informs the teacher about their level of understanding of a particular topic (Tanner, 2009). On asking Fortune whether he found doing his homework on time helpful, he said:

> "Yes, it is. Submitting the work before the deadline gives the teacher enough time to determine whether we have understood the topic or not. If we haven't, the teacher can make arrangements and seek other ways to help us comprehend the concept."

Fortune said the main reason for submitting his work on time was to allow the teacher to have more time to think of strategies to help students understand better. In case there was a delay in submitting the work, Fortune said he made sure he apologised.

> "I ask for forgiveness because this would result in a delay in planning for other lessons. Our teacher would not know whether we understand the topic and would not be able to continue forward to the next lesson."

Fortune's claim that their teacher did not jump to new concepts on discovering they had been left behind concurred with what their Physics teacher had already said. He would always go back to the topic if students did not understand. He was a considerate teacher. Even during the motivation phase, Fortune maintained he submitted his assignments on time so the teacher would have plenty of time to assess his performance.

Like Fortune, Mlungisi said he always submitted his assignments. He said he completed his work as early as possible to avoid the temptation of copying from other students:

> "It helps you to test yourself. There may be students whose work has already been marked by the teacher. You might want to look at their exercise book and copy it off. It is wise to write your assignment as early as possible."

Mlungisi seemed to believe in himself. He did not believe in submitting work copied from others. When asked again why he submitted his work on time, he said:

> "I'm a responsible person, who does not want to follow others."

When he was asked about feedback from the teacher in case it was delayed, he said:

> "I don't mind if there is a delay in feedback. I understand the teacher might be busy."

Mlungisi too was considerate of the teacher's responsibilities, just like Fortune. On being asked again, during the motivation phase, if early submission helped him, he said:

> "Yes. There might be times when I see another student's work that is different from what I have done and decide to copy it. This way I wouldn't know my mistakes and the part I am weak at."

On being asked if submitting his homework on time had any impact on his performance during exams, Mlungisi said:

> "It has had some positive contribution. When I submit my work early, my teacher makes an effort to see me outside of class and give me individual feedback and attention to help me understand the mistakes I have made. This means I have more experience and a better understanding of the topic when I write my exam."

Mlungisi received individual attention by his teacher. It would be a challenge for any teacher to pay individual attention to a student while teaching a group of over forty students. For a shy student like Mlungisi, individual attention outside of class helped him catch up with the group on concepts he found challenging. As for Goodwill, she submitted her work in time and believed that was part of her responsibilities as a student:

> "I think the purpose of coming to school is to do what the teacher says. And if I'm doing the homework, I'm helping myself."

Goodwill believed she was only helping herself by submitting her assignments on time. A sign that she was self-driven. When asked how she thought she was helping herself and not the other person, she said:

> "It helps me find out whether I've mastered the information that I learned or not."

She said if there was ever a delay in submitting an assignment, it was either because she faced difficulty in understanding the questions or because she tried looking for the information herself. However, she said she always went back to the teacher for guidance.

> "I usually submit my assignments. Though there are times when I don't understand a question and or I am unable to find information on my own. In such situations, I decide not to work on that question and instead ask the teacher. Sometimes I try to work on the question and show the teacher what I have done. If it's not correct, I ask him how to make it right. "

When asked if the assignments were helpful, she said:

> "They are particularly helpful when it comes to writing an exam. You are usually asked questions in your exam that are similar to the ones in your assignment. So you know how to answer the questions."

Goodwill valued assignments because they helped her practice for her exam. Her resources at home were a textbook published by McMillan and the internet:

> "I do my homework at home. I got a Chemistry book titled McMillan from the school. Though if I don't find the information I am looking for, I go to the library. Recently, they let me borrow a laboratory handbook. My parents have also given me a Smartphone that lets me download information from the internet."

While Goodwill visited the library at her school for extra information, she accessed additional educational material using her Smartphone at home:

> "The internet is no longer about having fun with friends. It helps me with my studies too. I Google information until I get what I want."

On the other hand, Nkhosinathi said he delayed submitting his work:

> "I delay submitting my assignments since I have to consult other colleagues and ask them for help."

Unlike Mlungisi and Goodwill, who would seek guidance from their teacher, Nkhosinathi preferred reaching out to his colleagues on encountering difficulties. He said he valued submitting his work on time but never before the deadline:

> "It is important to submit my work on time. If there are mistakes in my assignment, the teacher will correct it. He will then revise the topic in the class."

In another interview he said:

> "I want the teacher to check my work. It helps me figure out where I am lacking. I can then approach other students and ask for help."

After getting the feedback from the teacher, Nkhosinathi would revise his work and make corrections as soon as possible. He does not wait for the examination time to make corrections. During the motivation phase of data collection, Nkhosinathi improved from submitting on time to submitting in time:

> "It's helpful because I get special attention and more time with the teacher."

The students enjoyed individual attention from their teachers since their academic difficulties were solved. The motivation method seemed to have inspired Nkhosinathi to submit his assignments earlier than the deadline:

> "The teacher corrects your mistakes. It helps you understand where you have gone wrong."

The teachers were asked one question during the pre-motivation phase concerning the assignments.

Do the students observe homework submission deadlines for Physics and Chemistry class?

The Chemistry teacher noticed only a few of his students were submitting the work during the pre-motivation phase:

> "Some of them do, but the majority of them don't. I have to ask students for their exercise books during the class so I can mark them."

The voluntary submission was rare among the students in the Chemistry class before the motivation phase. On being asked how quickly he gave feedback to the students on the work they submitted, the teacher said:

> "Sometimes it's immediate, but in most cases, it's later since we only meet once or twice a week."

In cases of delay, the students usually asked their teacher for feedback:

> "If you haven't marked the assignments and returned them immediately, students tend to ask for it themselves. They usually remind you that they need feedback."

Here is what their teacher had to say about the effect of delayed feedback:

> "I think it has some negative effect, in that you find that they are pushing us to give them assignment feedback because they are eager to know what is going on in terms of what they have written."

Submission of assignments continued to be a challenge among the chemistry students throughout the pre-motivation phase. Their teacher said the reasons they gave for not submitting their work were simple ones, like forgetting to do the work. Students like Tiny said that at times she would forget to do her homework and go to sleep. Immediate feedback motivated students, especially positive feedback:

> "Quick feedback makes them even more motivated because when they get the feedback, especially if it's positive feedback, then they feel encouraged."

With the physics group matters were even worse when it came to submission of assignments:

> "That is the biggest problem I'm faced with. They hardly ever submit the work. That is another thing that I think counts to the poor performances, they do not complete any of the homework. So, it is hard for me to gauge how much they really know. They never meet deadlines."

The teacher stressed the seriousness of this problem, of students failing to submit assignments saying, they do not do any of the homework. The physics teacher gave his students feedback immediately, but he was often disappointed by the small number that would bother to complete and submit the work:

> "Well, I don't know if I can measure how much it helps because most of the time, you find that they did not even bother to do the work. Basically, it's me coming into the lesson to actually do the work they were supposed to do at home for them. About 10 % of the class will try to do the work."

Even during our second interview the teacher still faced the problem of having to force his students to submit their physics work:

> "That's still the biggest problem, submission of work. Most of the time they would do it once you've promised some form of punishment if they don't. But there is that minority that does submit on time."

Seemingly, punishment was the language most of the students understood – operant conditioning (Louw & Edwards, 2010). For the few serious students their efforts paid off as their teacher observed improvement in their understanding:

> "... another problem with my students is that they really don't give themselves time beyond the classroom to do the work. Those that do give themselves time are the ones that show a big improvement. You can see the changes, they do understand the work."

Those who submitted because of fear of punishment copied from the few that were serious. That worried their teacher:

> "Most of the time you can see that it's the type of work that only one student does and then the rest will come and "seek assistance', if I may call it that. You can see that some of them did not even give themselves time to actually think about the assignment they are supposed to be doing. Do they have the understanding? That is why I'm saying there is that minority that will actually give themselves time to do the work; and then the rest of the students will then try to copy from those few individuals."

The last question for the students addressing performance during phase one of data collection was:

> "How can your performance in chemistry/physics be improved?"

When Daluthando was asked this question for the first time she did some introspection. She confessed her wrong doings of not paying attention to the teacher and failing to complete her physics assignments:

> "By listening when the teacher is teaching and doing the assignments he gives us."

During a second interview, Daluthando suggested group discussions in addition to the previous ways of improving her performance in physics:

> "By being involved in group discussions with my colleagues, listening to the teacher when he is teaching the class, and doing the work he gives us."

During the last interview of the pre-motivation phase Daluthando suggested brainstorming:

> "By forming discussion groups with my colleagues. It is very important because some of my colleagues can give different answers or solutions, which I did not think of."

Daluthando also suggested collaborative learning, saying that when working in groups members encouraged each other to come up with new ideas. During the second phase of data collection Daluthando cited doing lots of assignments as one of the methods that could improve her performance in physics. In another interview she said:

> "By researching the things that I find difficult; by listening to the teacher when he is teaching; and by seeking help from my colleagues by forming study groups."

The motivation method seemed to have incentivized Daluthando because she seemed to be more concerned about her progress. She mentioned doing research on the things she found challenging. She had taken ownership of the learning process. She had even realised that the teacher had to give them more physics assignments, and by doing corrections:

> "By giving us more homework and doing the corrections when he has given us difficult work, and doing examples on my own."

Doing examples on her own would help Daluthando develop the skill of self-explanation (Ionas et al., 2012). Self-explanations help students synthesise new knowledge by relating knowledge they already possess to new concepts. Tiny, just like Daluthando, suggested group discussions and group work as ways that she thought would improve her performance in physics:

> “Group work and discussions.”

In another interview Tiny mentioned a private tutor as someone who could help her do better in physics:

> “By having a private tutor or group discussions.”

A private tutor would be a good facilitator of the learning process since the tutee would get all the attention. Scaffolding would assist Tiny with the calculations involved in physics problems. In another interview she mentioned practice as an act that would improve her performance:

> “By practising.”

Doing her own examples in addition to the work given by the teacher would help Tiny understand physics concepts better. She would learn from self-explanations. She also mentioned study groups as helpful towards making her perform better in physics:

> “I think the study group can help me a lot. In fact it is helping.”

By that time Tiny was a member of a study group and that was helping her improve in her physics performance. During the motivation phase she suggested that if the calculations could be made much easier she would improve in physics:

> “If the calculations could be made much easier than the ones we have now.”

Tiny’s comment suggested she did not intend further study of physics because the calculations would get more complicated with advanced physics concepts. She also suggested afternoon classes as well:

> “I think afternoon classes can help, that’s where we’re open to talk about the difficulties we have and we can work on them as a group with the help of the teachers.”

The suggestion of being able to discuss their difficulties during afternoon classes was a good idea and would make her improve in physics. The teacher would be there merely to facilitate the learning process.

Fortune thought if his classmates were disciplined for noise, then he would concentrate better and thus perform better:

> "I think it would be better to apply discipline to all the students because they sometimes don't listen to the teacher, or they will be talking while the teacher is teaching. It would be better if the teacher can discipline them so that they must concentrate on the lesson. That way they will pass the subject because physical science needs concentration and a lot of practice. Maybe if the teachers can organise extra assignments we can pass the subject."

Like the other students Fortune noted that concentration and lots of practice were needed for improved performance in physical science. He also added group work as another requirement for better performance in physical science. During the last interview of the pre-motivation phase he mentioned self-commitment as another important characteristic for better performance in physics:

> "I think self-commitment can improve the results in physics and if we can form some groups and work together, our results could improve."

Fortune did some introspection and realised that he needed to be a self-regulated student. Self-regulated behaviour is characterised by aspects such as self-observation, self-assessment and self-reinforcement (Bandura, 1986). In our last interview he mentioned the attributes of self-regulated behaviour, saying that they could help him improve in physics:

> "I think if I can do more work, more homework, more talking in class and more group work. This way I can master all the formulas in the subject."

Mlungisi suggested that if they could have more time learning chemistry that could help him improve. He said that their chemistry periods were fewer per teaching cycle:

> "It can be made better by increasing the number of periods in our timetable because we have only three per six-day cycle. When the teacher comes today, he will not come again until next week. By then, you find that you've forgotten what you had been learning in the previous lesson."

Mlungisi mentioned the time gaps between chemistry periods were detrimental to the learning of the subject. There were very few chemistry periods during the six-day cycle and they were spread far apart, with only one single period and one double period. Several processes of classical conditioning were involved here such as reinforcement, response acquisition, extinction, spontaneous recovery and generalisation (Watson, 2013). He complained that between the chemistry periods there were too many other subjects to focus on. Even if they would do the chemistry at home they would end up forgetting what they had studied. Mlungisi had only one worry (the number of chemistry periods) which he said if modified, then his performance would improve.

Goodwill mentioned several ways through which she thought her performance would improve such as using the library, science textbooks, past examination booklets and talking to science teachers. She thought engaging actively in chemistry experiments could help improve her performance, as would having a positive attitude towards the subject:

> "I've observed that many people have a bad attitude towards chemistry. They say chemistry is tough; you only do well if you are a brilliant student. No, it's not like that. You have to like the subject. Don't have a bad attitude towards it. Study it, work hard. Try."

She believed hard work and persistence would help a student improve in academic performance. Goodwill thought copying of assignments from other students had to be avoided. Copying resulted in students only having a superficial understanding of chemistry concepts (Tanner & Allen, 2005). When asked about the importance of relying on oneself Goodwill said:

> "Yes and doing a follow up. If you don't understand you go to ask your teacher or any science teacher."

Goodwill also thought her performance, and that of other chemistry students, could improve if there could be a separate chemistry book with practice questions. This would be unlike the present situation, where the physical science textbook had both chemistry and physics together in one book.

Nkhosinathi thought seeking help when he did not understand helped him to improve in chemistry. He also thought extra classes would help the students. The extra classes would be conducted outside school hours. During the motivation phase Nkhosinathi thought if teachers of other subjects, such as mathematics and biology, would adopt the motivation method then the school would get better results at the end of the year.

Teachers were also interviewed about strategies that could improve student performance, particularly in chemistry and physics.

One of their suggestions dealt with the setup of the laboratories themselves. The chemistry teacher felt that having lessons take place in laboratories was essential for conducting experiments as well as for holding student attention:

> "I think in most cases we need to conduct lessons maybe in the lab because they feel like this is a science subject. So, when they are in the lab they feel like this is the right place to be, and [...] if you're doing the experiments with them they are sometimes excited."

Some of the student participants stated that experiments help them learn by providing a more hands-on and interactive experience. According to one teacher:

> "It makes them even more motivated because some of them even ask to partake in dangerous demonstrations, like maybe reacting alkali metals and other things. So, they become very excited when they see things happen."

Experiments can also help when a concept is particularly abstract or challenging for teachers to explain. Said one teacher:

> "I think we need to have more of the practicals, especially on those topics that are a little bit very—what do you call it—abstract. [...] You need to make sure that they see some of the things happen."

Science laboratories are well suited for experiments. Storerooms for chemicals and equipment are conveniently located within, or next to, the laboratories, allowing teachers to do as many experiments as necessary.

Motivation was also a core element brought up by teachers. The physics teacher felt the physics students benefited from occasional encouragement. He also solved problems with them in class on the chalkboard as a way of instilling a positive attitude about the subject.

During the second phase of data collection the students were asked a question about their performance. The question was: How is your performance in chemistry/physics?

One of the students, Goodwill, noticed improvement in her performance since the introduction of the motivation method. She attributed her improvement to concentration during lessons and consistently submitting assignments:

> "I can say my performance is better now. It's not like the first time I started chemistry. At first I felt like chemistry was very hard for me. I thought of giving up. But now I enjoy it and I concentrate in class. What I like most is that we learn about current things that even most of our scientists are worried about. So, I now focus and I write my assignments. What helps me most is the submitting of assignments because when the exercise books are returned you can see what was hard for you and what you have mastered [...] and you are able to do your corrections."

At the beginning, Goodwill found chemistry challenging and was intimidated by the subject because she perceived it as difficult:

> "Yes my performance is improving. At first it was a very challenging subject because there are these scientific names that it was my first time to hear of or just to see. So, I was wondering 'What's the meaning of these words? Am I going to make it?' and I had just heard some rumours people saying that 'Ah! Chemistry is challenging, chemistry is bad.' But I haven't seen that so far."

Another student, Mlungisi, observed fluctuations in his understanding of certain topics.

> "Sometimes it is caused by the topics. So, some of the topics are quite difficult, but not that much. So, the understanding may not be the same."

After another test, Mlungisi observed improvement in his performance, with his mark increasing progressively from 80, to 85, to 90 percent in each subsequent test.

Mlungisi's performance was improving steadily even though he claimed his understanding was fluctuating. One could observe a steady increase of 5% after each test (see Table 4.2). When he was asked if the improvement was caused by the method their teacher was using to motivate the class, he said:

> "Yes sir, because in the test I remembered everything that we did in class practically. So, the motivational method helped me very much, Sir, in remembering even tricky things, because we have done these things practically."

So, the chemistry teacher paired the motivation method with teaching methods which appears to have improved student performance.

Nkhosinathi also noticed improvement in his performance, saying:

> "I'm doing well so far."

When asked if his performance had improved compared to during the pre-motivation phase he said, “It has improved because my marks are increasing.”

Improvement of marks and understanding in a subject can be indicators of being motivated to learn the subject. Therefore, the motivation method seemed to have motivated Nkhosinathi to study chemistry:

> “I think I’ll do much better than I’ve been doing in my tests,”

Fortune was another student who observed improvement in his performance. When asked for the reason for his improvement Fortune pointed to the teaching strategies the teacher used, as well as the motivation method. “I think the reason is that our teacher gives us more work and the chance to work in groups so that we understand everything better.”

Daluthando also reported improvement in her performance in physics. As did Tiny, who reported improved understanding and who enjoyed the discussions that went on during lessons:

> “I think it’s working. The more we talk; in fact it gives us the energy to talk so that we can get the 0.5 mark.”

After being asked whether the 0.5% mark encouraged her to engage more in physics lessons than before, Tiny said: “Yes, talking makes us understand physics better.”

Test and quiz scores on average were higher for the motivation phase than for the pre-motivation phase as shown in Table 4.2. In some cases, examination scores for papers were also improved, as seen in Table 4.1.

Tiny’s average scores for the quizzes for the pre-motivation and motivation phases were 62% and 72% respectively; likewise they were 43% and 53% for her tests. For the quizzes, Tiny made a 16% improvement between the two phases of data collection and a 23% improvement in her test scores.

When Tiny was asked to predict her performance after writing a physical science examination paper she responded by saying:

> "Ah, the paper was fine. It's just that the first two questions were a bit challenging. Otherwise the paper was okay. I hope the CA will improve my final score."

Tiny states that she found the examination paper manageable because of the motivation method. Indeed, Tiny performed better in her final examination papers (Papers 1 and 2) compared to her performance during the mock examination (see Table 4.1), which was written during the pre-motivation phase. In fact all the participants did better, on average, in the papers they sat for during the motivation phase as compared to those they sat for during the pre-motivation phase. Even Daluthando improved, though all her scores were below the pass mark (50%). Indeed, the 0.5% motivation marks appear to have made a difference to all the participants' final scores (see Table 4.3).

Table 4.1 Tabulated scores of mock and final examinations

Physical Science Components	**Student names**	**Pre-motivation Phase: Mock Examination**		**Motivation Phase: Final Examination**	
		Paper 1	**Paper 2**	**Paper 1**	**Paper 2**
Chemistry	Goodwill	54	52	61	56
	Nkhosinathi	40	58	53	50
	Mlungisi	75	88	93	80
Physics	Tiny	31	39	56	51
	Daluthando	21	33	46	48
	Fortune	41	45	64	61

During phase one, the physical science teachers were asked about their students' performance in chemistry and physics.

This question was followed by two other questions related to performance and motivation: How quickly do you give them [the students] feedback on submitted chemistry/physics work? And what effect does the feedback have on student motivation and understanding? According to the chemistry teacher, his group was performing well even before the motivation method was used with them. When interviewed about feedback and its effect he said:

> "I think it has more negative effect in that you find that they are pushing that we should give them the feedback because they are eager to know what is going on in terms of what they have written."

The chemistry group seemed to have been a motivated group, because after submitting they would follow-up on their performance with their teacher. They were a group of self-regulated students. Said one teacher:

> "It is helpful in that it makes them even more motivated because if they get the feedback, especially if it's positive feedback, then they feel that they can do things."

The physics teacher had a demotivated group and that group's outcomes were not as positive:

> "The performance is not so good. It's, I can say at this point, it is below average. It is not good in that they lack the motivation for the subject."

Like the chemistry teacher, the physics teacher gave his students feedback on submitted work as soon as he met them for the next physics lesson. But prompt return of student work seemed to help only those few that submitted their work at all:

> "Well, I don't know if I can measure how much it helps because of the fact that sometimes, most of the time actually, you find that they did not even bother themselves to do the work. So, basically it's me coming into the lesson to actually do for them the work they were supposed to do at home. So, it is always me. About ten percent of the class will do the work, and for that little ten percent they do try."

The shrugging of shoulders by the teacher could have been a sign of despair. So, the teacher's feedback and revision only helped a small percentage of the students, especially those that submitted their work for marking. But things changed later. The teacher started noticing improvement in the behaviour of the students:

> "Well, lately they have been improving a lot. I think that something somehow is working. They are doing the work. There is some slight improvement in that they do try, even if there are some difficulties. Some of them do now give themselves time to actually come and ask questions pertaining to the work [*sic*]."

Some of the students became serious with their schoolwork, and the teacher noticed improvement in their understanding of science concepts:

> "Another problem with my students is that they really, really don't give themselves time beyond the classroom to do the work [*sic*]. So, those that do give themselves time beyond classroom hours do see a big improvement. You can see certain changes that they do understand the work. [*sic*]"

The physics group seemed to be showing very little improvement during data collection. However, on analysing the scores for both examinations, the physics group benefitted from the motivation method more (55%) than the chemistry group (7%). The next question to be addressed was asked during the motivation phase: Had student performance improved in comparison to phase one? The chemistry teacher reported improvement, indeed, but this was also seen during the pre-motivation phase. As a matter of fact, he noticed even greater improvement.

Even their test scores (Table 4.2) on average showed an improvement of 30% between the two phases of data collection:

> "... I was looking at the tests and noticed the majority had passed even though this is a topic that usually gives them some problems because it's stoichiometry [*sic*]. Sometimes stoichiometry is a little bit tricky. But for them, the way they learned it, it was interesting and the results are marvellous."

The students themselves reported that they had heard rumours that stoichiometry was a very difficult topic, but to their surprise they enjoyed and passed it well. So, the teaching methods, together with the motivation method, motivated the students enough to appreciate their learning, and thus found it interesting and manageable. The improvement was observed even in their examination scores (see Table 4.1):

> "Their performance in the examination improved, although not by that much [*sic*]; but there is some form of improvement."

For the physics teacher, some students showed improvement, while others did not:

> "Some of them have improved quite a lot [*sic*]. But I think maybe that is due to the fact that we're nearing the end of the year. Maybe they are starting to see the importance of doing well in the subject. But in general terms, some of them are just still not showing any improvement at all. [*sic*]"

Even during a second interview, the teacher reported slight improvement among some of those students:

> "At this point, with the motivational instrument we are currently using, it has slightly made a difference. Albeit, not that significant, but it has made a difference in that some of them are starting to notice that they need to push hard to improve their marks. [*sic*]"

So the physics students were one by one realizing the importance of improving their performance in the subject. Their low examination scores shadowed the great percentage improvement they made from the twenties, thirties and forties they scored during the mock examination, to the forties, fifties and sixties they scored during the final examination (refer to Table 4.1). In fact, the physics students showed a much better percentage improvement in their examination scores between the two phases (55%) than the chemistry group (7%). The last question under performance was:

> Do they ask for more work than you give them?

> "Yes, they do. But in most cases, when I teach them, I give them some classwork. Then when they do it, we might find that they may want more practice. [*sic*]"

During a second interview, the teacher observed that a few students started asking him questions from time to time:

> "Only a very, very limited few will from time to time ask those few questions. But I can say that generally they don't. They do not ask as much as they are supposed to, especially since physics is something that needs you to be alert. When you're doing physics you need to ask questions. So, the rate that they are asking at is not satisfactory."

So, the students did not ask for more work, but asked a few questions. That was the case with the group throughout. Moreover, the questions were asked mostly by boys. The boys were more than the girls in the group:

> "They have not been asking for more work per se, just hints of what might come out in the assessment. But for work, just two out of a class of forty boys tried to ask those few questions."

The interviews conducted with the students, together with their physical science teachers, revealed that the motivation method in general encouraged the students to engage more in science discourse than before it was employed. Generally the method encouraged the students to talk more in class and to write more science work with better understanding than before.

So, the motivation method was working even for a difficult group like that physics class. Their teacher observed that the method was forcing some of them to engage in lessons, so that they could get those marks. Engaging in lessons helped the students to concentrate to their teacher and to understand the concepts taught:

> "Engaging is helping in that now they are able to conceptualise those discussions that are happening in class; rather than to just sit back and let me do all the work. So, that tells me there is a little difference there in terms of participation."

So, the students were slowly owning the learning of physics rather than taking it as the teacher's subject. During a second interview the physics teacher said he thought the motivation method was going to be effective once the students got used to it:

> "From my view teachers of other subjects can adopt the method for the simple reason that the students will want to gain those extra marks. At any cost they will try to at least gain those few extra marks. I think that it will be effective. At some point once they are used to it (both students and teachers) it will be an effective tool."

The teacher thought it was good for the students to participate more in lessons that would motivate them to want to understand the subject:

> "Yes, I would still recommend the method in that it helps the students to want to participate. I think when they want to participate it can also in the long run improve the motivation of them actually wanting to understand the subject much more better."

During a third interview the physics teacher thought other teachers could adopt the method since it made the students to participate more in lessons, thus indirectly enhancing their motivation towards the subject. Here is an abstract to illustrate this:

> "Yes, I'd very much recommend it because I think the tool will also help in engaging the students I the fact that they will want to participate for the sake of getting that extra credit for the subject. So, indirectly it might just help to increase the motivation towards liking the subject. But for those that do try to engage and take advantage of the situation, I have seen an improvement in their marks. But I haven't really measured whether it's simply

> because they've been improving for the fact that the year is almost over, they want to improve their marks or they are just getting better in the subject."

For those that engaged actively in the lessons their teacher observed improvement in their scores; which would be attributed to improved understanding of the subject. When the teacher was then probed about other methods that he thought could make his students do better, he recommended a practical approach to teaching physics:

> "As a new teacher at this point I would say that for now it would go back to the fact that I need to increase the practical approach to the subject. I think it will decrease the fear of the subject in some of the students. Because when you think about the concepts, especially for this year, like the levers and the moments. An example I made in class of that when you open a door, that's typically an example of a moment. So, you basically spend your entire life opening doors. That's all physics, levers. The arm is an example of a lever. That's stuff that you experience day to day. So, maybe if we could approach the subject in that situation. The fear of the subject will decrease. From what I'm seeing students just come to physics having accepted that they will fail. So, some of them don't even try at all because they have accepted the fact that they can't do it."

A practical approach to teaching sciences indeed helps drive abstract information into the minds of students. Though students at high school are in the formal operations stage of cognitive development they do at times regress to the concrete operations stage (McCown et al., 1996). This is common with information which students find difficult to imagine or understand; a concrete example then comes in handy. The best experiment or practical is one where the students are involved, not just a demonstration by the teacher.

The issue of students coming to physics having accepted failure of the subject is a sign of helplessness and lack of hope. Natural science teachers need to remove the stigma of the subject being viewed by students and parents as difficult or impossible. Once that stigma has been removed then there will be no more fear of the subject by the students. Another question which teachers were asked which was categorised under motivation was:

Question: How has the motivation method used with the students contributed to their talk, understanding and performance?

When the chemistry teacher was asked this question he responded as follows in one of the interviews for the second phase:

> "It has improved how they listen in class because you find that they are more attentive. When it comes to answering the questions they are awarded some marks for correct answers or responses. So, then they make sure that they try as much as they can to get those good responses, even if it calls for calculations you find that they try to calculate far ahead of the others. So, the class is moving at a faster rate."

Seemingly, the motivation method improved the nature of the chemistry lessons. The teacher noted improvements in attention, answering questions and rate of doing work. The students can thus be said to have been motivated by the motivation method, and their understanding improved as their teacher noted an improvement in giving correct responses. When probed about the progress of the class if the above abstract meant it had improved, he agreed:

> "It has improved a great deal."

In another interview the chemistry teacher said:

> "Yeah! It has contributed a lot. You find that you do not even need to ask them some questions. They are ready to answer anything you ask. Even if you write something on the chalkboard, you find that they are figuring out the answers without having to ask if this is a question. When I'm writing the question on the board, immediately I turn I find some answers ready for me."

So, the students were competing to do well. The physics teacher also noted some positive contribution of this method towards the teaching/learning process. It improved communication, understanding and attention during physics lessons. Here are transcripts to show it:

> "The method has really improved in terms of that situation of communication and wanting to participate in class. I can say that it has really motivated the students to want to be active and engage in those particular discussions in class. So, it is, I can say that the method is working. There is improved understanding now in terms of subject matter situation. They now, because of that extra credit, they actually listen to my lessons so that they can be able to be in a position to answer questions and get those credit points."

When the teacher was asked about the students' behaviour if it had improved he said:

> "Eh! The behaviour? Not that much. There are still some students that from time to time will want to avoid coming to class. But generally some of them are showing a slight improvement. There are those that make it a habit to deliberately not come to class."

In another interview the physics teacher mentioned that his students had started asking and answering questions in class:

> "The motivational instrument we're using there it helps. They do try now. All be it sometimes the answers, the questioning is not well thought through. But because of that extra mark they are trying to engage or to have that engagement with me as their teacher."

In another interview the teacher noted participation in lesson activities to have improved, not understanding:

> "I think for that one the only aspect it helped in was in just that there was more participation rather than, not necessarily the understanding, but rather the participation increased a bit. Performance was more or less the same."

When asked if participation in talking helped the students the teacher agreed that it helped:

> "Looking at the topics from the last few lessons I will say that it helped in that most of them managed to remember most of the stuff that we did when the tool was introduced. There was just a slight improvement in terms of answering questions there."

The physical science teachers were asked if they motivated their students to talk in class, and what strategies they used.

Question: Do you motivate your students to talk in class? What strategies do you employ?

The chemistry teacher said he motivated his students, especially at the beginning of the lesson. He claimed to use the 'question and answer' method. He posed questions to the students and expected them to respond. In case the students did not respond he would rephrase the questions. If there would still be no response then he would purposely point at those students he knew would give answers. Here is an abstract to quote the teacher:

> "I use the question and answer method, so whereby the students are, I pose questions and I expect them to answer. If they don't answer then I happen to rephrase those questions. If there are still no responses I try to excite the talking by pointing at those people of which I believe they are going to give me some answers."

The physics teacher too motivated his students. Here is an abstract to illustrate this:

> "Yes I do motivate them in terms of the fact that we once went to that workshop ye discovery learning; where basically you have to interact with the class. You don't basically give away all the answers or whatever you're teaching to them. They've to actually discover what you're driving towards as the teacher. So, I would say that I do motivate that they participate in that particular topic. I do ask before actually giving them the answer."

So, the teacher mentioned discovery learning; something one of his students mentioned. Discovery learning stimulates students to engage in the subject matter and it helps them develop all the science process skills, even the advanced ones (integrated skills). Here is another abstract in which the teacher explained how he motivated his students:

> "Upon seeing that they have attitudes towards the subject I do in class try to make them participate; so that there is a link between myself and the class. This will make sure others can see that this is indeed a doable subject, because if one of them is able to answer the questions, others will be motivated to say 'Oh! I myself can be in a position to answer questions in class."

According to the abstract the teacher tried to establish a rapport with his students, something which creates a good atmosphere for teaching and learning. When asked for strategies he used to motivate his class he said he did that by outlining what the subject was all about and also by working problems on the chalkboard for the students to see that they could do them too.

According to what the physical science teachers said during the interviews for the pre-motivation phase, they were motivating their science students to engage actively in science lessons. However, their students were not that much motivated to learn physical science – something this study wanted to accomplish.

4.2.1.1.2 Talk

Student talk was one of the themes that came up from interview data. The questions that students were asked during the interactions that pertained talking discussing talking during science lessons were basically three:

1. How frequent do you talk during chemistry/physics lessons? Never, rarely, often, always.
2. When do you talk during chemistry/physics lessons? Is it when you're asking questions, answering the teacher's questions or only when probed by the teacher?
3. Is talking in class helpful? Give reasons.

Teachers were asked one question during the motivation phase, and was:

Question: How often do your students now talk during chemistry/physics lessons?

Daluthando said she only talked in class when asked questions by her physics teacher. When asked if talking in class was really helpful she said:

> "Yes it is helpful because you find that when we write a test we try to remember the answers we've said in class."

The claim by Daluthando that talking during lessons helped her to recall answers is backed by Tanner (2009). Tanner (2009) states that talking enables students to process information. But the challenge Daluthando had was that she contributed to science lessons by answering teachers' questions; she said she never asked teachers questions. When asked why she never asked questions in class she said she was scared of her teachers. In another interview Daluthando mentioned the importance of talking in class as follows:

> "Talking in class is part of communication when you're learning as a student. So, talking in class is very very important. It leads us to pass."

So, Daluthando knew good communication in class led to academic success. But she never engaged fully in class. When asked during the motivation phase why she did not talk during physics lessons she said she preferred writing to talking in class. Here is an abstract to illustrate this:

> "Sometimes I feel like it is better to write down than talking, according to my own understanding."

So, when probed if she would like it if the teacher would just give them more notes and talk less, she said she would like it that way. From this statement one may guess Daluthando's learning style. She would have been a visual learner since she preferred being given detailed notes on the chalkboard than lots of explanations. Though Daluthando knew the benefits of talking during lessons she claimed she did not talk. Her reason was fear of being laughed at by her friends. The following transcript illustrates it:

> "Keeping quiet does not help me because if I talk to the class I will remember the answer I have said in class, just because of fear of the students I don't talk. They may laugh at me when I say the wrong answer."

Indeed students of her age are so conscious of their image because they are still discovering their identity. Tiny too behaved like Daluthando in class; and that was when asked questions by her science teacher. But she also knew the importance of talking in class. Here are transcripts to illustrate that:

> "If maybe I make a mistake in class, maybe the teacher corrects me, then I get to know that."

> "Because you get to learn if you don't know something. But sometimes it is not helpful because you can talk and talk and talk. In fact writing is better than talking."

The next abstract followed her response to a question she was asked if talking was helpful. Her response was:

> "Somewhere it is helpful and somehow it is not."

In a subsequent interview Tiny felt talking during science lessons was not helpful. An argument for that was:

> "Because the following time I'll forget whatever the teacher said. Instead writing is better than talking."

According to Tiny things said to her quickly evaporated and things written down stuck to her memory. But during the last interview with her of the first phase of data collection she said she often talked in class, and that was when she was answering the teacher's questions. When asked why she never asked her teacher questions she said:

> "I'm afraid. I'm shy."

When asked who she was shy of she said:

> "Of the other students."

Again when probed why she was afraid of the other students she said:

> "I'm just scared of talking in the mist of many people. Like, they imitate me the way I talk."

When asked if they liked the way she talked she responded by saying:

> "They just make fun of it. To them it sounds unique. To me it is not."

So, with Tiny the other students were impressed by her quality of English language and the way she was pronouncing the words. Again when asked about talking if it was helpful, she stuck to her idea that it was not:

> "Talking? If we talk today the following day I might forget whatever we said yesterday. I prefer writing instead of talking."

Tiny, and perhaps other students like Daluthando were forgetting that both talking and writing were important during the teaching/learning process. So, teachers and students need to strike a balance between these two activities. They help in cognitive processing of information. In our first interview during the motivation phase Tiny seemed to have changed her idea of disapproving talking in class. She had started seeing the usefulness of talking during science lessons. Here is a transcript:

> "It is helpful coz if I get something wrong and the students laugh at me, by the time the teacher corrects that it will be stored in the long-term memory."

So, according to Tiny the benefit of talking in class is that when a student is corrected in front of others that correction stays in the long-term memory. By the second phase of data collection she had realised that her being shy and afraid of talking in the mist of her colleagues was not going to benefit her. In a second interview with her she again agreed that she talked during physics lessons and that benefitted her. Here is a transcript where she explained the benefit of talking in class:

> "Because once I'm corrected somewhere somehow I won't easily forget that one."

It seems the motivation method indeed motivated her to talk during lessons despite the humiliation from the other students about the way she talked. The issue of talking during physics lessons was different for Fortune. He would always talk in class. He claimed during the first interview of the pre-motivation stage that he even asked questions during lessons. Following is a transcript to that effect:

> "I always talk Sir when I'm asking questions."

When asked how helpful talking was during physics lessons he said:

> "It helps me a lot. Not only me but even the whole class because I understand the most when I ask questions from the teacher."

Fortune noticed that when a student asked the physics teacher some questions even the other students that fear asking benefitted. Those were students like Tiny and Daluthando. When probed more about the importance of talking to the teacher after class he said:

> "Au! I'm not used to doing that."

Seemingly, most of the students that took part in this study did not seek help from their science teachers outside class; only Mlungisi did so. In another interview when Fortune was asked if he talked to his friends during lessons he said:

> "I don't talk to friends because I will disturb the teacher when teaching."

Seemingly, Fortune would give the teacher his full attention. When asked how helpful talking was to Fortune responded by saying:

> "You understand better when you talk, ask questions and respond to a teacher. You understand better what the teacher is teaching you."

Fortune believed in interactions during lessons for proper learning. He did not believe in piling up questions while the teacher was right in front of him. He asked questions immediately not only during physics lessons, but also during other subjects. He also asked questions not only for his own understanding but to benefit the other students too:

> "It helps me to understand the lesson the teacher is teaching me, but not only me but the class too benefits while I'm asking some questions from the teacher."

According to Fortune asking gives the teacher more time to explain concepts to students:

> "We students easily understand when we ask what we don't understand and the teacher gets more time to explain, and others understand when we ask."

Mlungisi was one of those students that claimed during the pre-motivation phase that they never talked during chemistry lessons. He mentioned fear of embarrassment as his reason for not talking:

> "I used to never talk in class."

> "I'm afraid of embarrassment just in case if my answer is wrong. So, the other students may laugh. So, I'm afraid."

When asked if laughing at each other was beneficial, Mlungisi said:

> "No! It is not beneficial. No, it is not."

On being probed about the reason for laughing at each other he said:

> "(Soft laughter) I don't know the main reason for them to laugh."

So, when probed if he found keeping quiet during lessons important he responded as follows:

> "No, it is not important because sometimes you lose concentration. When you're quiet you may sometimes get outside of the lesson; thinking other things."

Mlungisi was very correct; an actively engaging student follows a lesson. Should such a student be left behind then it will be easy for the student to say where exactly the problem is. A dormant student will indeed start wandering about other matters outside the lesson content. During a second interview Mlungisi stated another importance of contributing when learning:

> "Because immediately when you say something in class, so when it comes out in a test or in an exam, it will be easy for you to remember it because it was said by you in class."

On being probed on how he engaged actively during lessons he said:

> "I listen to others when they talk and try to understand their concern and the teacher's response."

From the above transcript one can conclude that Mlungisi was one such student Fortune talked about that they benefitted from what others contributed in class; those that never talked themselves. Mlungisi was so afraid of asking such that he used other students around him when he had a question:

> "Being afraid sometimes helps me because I listen to the others when they talk. Sometimes I even use Nkhosinathi to ask for me a question because he sits next to me. So, he asks that question and I listen to the response of the teacher."

When he was asked if he thought Nkhosinathi was not afraid of embarrassment, his response was:

> "Yes, Nkhosinathi is active. So, even if he is wrong (soft laughter) he also laughs when they laugh."

Mlungisi's biggest challenge was that when the others laughed at him he became shy. When asked if being shy benefitted him he said:

> "No. It does not benefit me but it's just my nature. I'm afraid to show up."

Such behaviour as Mlungisi's caused many high school Swazi students to be reserved during science lessons. Mlungisi continued being afraid of asking or answering questions even during the motivation phase. He used Nkhosinathi whenever he wanted to contribute. In another interview he emphasised the issue of asking questions using another student (Nkhosinathi) that it benefitted him:

> "Yes Sir. It is helpful because when you don't understand something and he asks it from the teacher, then you have a clear picture about that."

By the middle of the motivation phase of data collection Mlungisi revealed that he had started talking among his classmates during experiments. He said this when asked about the motivation method if it had changed the pattern of talking during chemistry lessons:

> "Yes Sir. It has changed the pattern because most of the time, let me make an example, when we're doing the experiments the teacher divides us into smaller groups. So, it is easy to talk in front of a small number of people. So, even if they can laugh they're controllable than the whole class. So, I tend to talk when we're in those smaller groups."

The smaller groups, seemingly, encouraged shy students like Mlungisi to develop self-confidence (Hott et al., 2012) to talk among the other students. Indeed student talk is the central part of many active, innovative and inquiry-based approaches to teaching (Tanner, 2009). When Mlungisi was probed further about the whole class if it was benefitting from the motivation method he said:

> "Yes Sir. It has also helped the class because even the marks that they get, the lowest and the highest; the range is not that much."

So, the motivation method improved even the nature of the whole chemistry group. In our last interview when Mlungisi was asked if he thought the class had gained from the motivation method he said:

> "It has gained a lot because there is great improvement even in the participation in class. Students were able to participate with the teacher. So, it was very easy when the teacher asked a question to raise up their hands and responded quickly to the teacher."

Seemingly, Mlungisi was excluding himself from those students who had been encouraged by the motivation method to raise up their hands in class. With him he had gained the confidence to talk during group work where there would be no need of raising up hands before contributing. Goodwill was the opposite of Mlungisi; she always talked in class. When asked about what made her talk in class she said:

> "When I'm asking a question or I'm answering the teacher's question. I'm not afraid and I ask a lot."

When asked about the importance of talking during chemistry, she responded this way:

> "I want to master the information Sir because sometimes I don't get the time to study but, but when it comes to tests or an examination, I just recall what the teacher said in class. Talking is helpful because you ask a question when you don't understand and the teacher gives you the answer."

Goodwill believed in mastering information in class while the teacher was teaching, not later when she was by herself. That helped her in tests and exams; she would just recall the answers she gave and those she was given in class. She even liked it more when the teacher gave examples when explaining because during tests and exams it would be easy for her to remember those examples. Something good about Goodwill was that she would go beyond asking and answering questions to debating during chemistry lessons:

> "Yes, as for me I ask a very lot and sometimes I debate with the teacher. If I just don't get it or if I've learnt this thing before maybe in another book I say 'teacher no no no'. I think there is a better way of doing this; and when my way is not a good way the teacher gets to explain it that no you can do this and that."

When probed about asking the teacher if it benefitted her she said:

> "It benefits me a lot because when I ask the teacher is supposed to give me an example, then I master very well. Yes it's very helpful."

In an interview during the motivation phase when asked if she talked during chemistry lessons, Goodwill gave a loud sigh and she said:

> "Oh! I talk a lot. I ask the teacher and argue a lot. Sometimes you can think this student is so disobedient. No! I want to know. I want the teacher to give me a clear example. Yes, to master the thing. If it happens for me to forget maybe the meaning of the thing, maybe of the term. I start to think, to recall about the thing, maybe the example, and then the information it will just flow again."

Lessons with students like Goodwill are usually very lively; where there are constructive arguments that come from the students. When probed about the importance and helpfulness of talking in class she responded this way:

> "It is very important; and asking a question if you don't understand. It helps me a lot. Even arguing because as we are children our performance is not the same and our minds are not the same. Some are average. Some are better than others. You know, we start to argue, the other student will say this, the other student will say that, and then the teacher will explain the correct thing to us. And I enjoy it so much. I value it very much. To contribute it is very important, not just to keep quiet. Not feeding from others but talk also, ask. Your suggestions even if they are wrong, they will correct you. "

So, Goodwill was unlike Mlungisi who would ask questions through Nkhosinathi. She believed in herself and expressed herself fully during lessons, not through other people but doing it herself. When asked if she did not mind being corrected she said:

> "I don't mind being corrected. I like to laugh. Some students, if you ask something, laugh. They say 'Ah! This one is just asking funny things'; and me I'm being helped so much. And I enjoy it."

Despite the behaviour of the class to laugh at other students Goodwill had courage since talking during lessons benefitted her. In one other interview she claimed her chemistry teacher could testify that she contributed during lessons:

> "I talk a lot and I ask questions and I debate too a lot with the teacher. I like it. Even my chemistry teacher can say that Goodwill is always talking, asking questions."

When probed about her being active during lessons she said:

> "I'm always active and look at the teacher, because once I don't look at the teacher I will lose focus. I will just think about my other things. I concentrate and it's helpful even to debate because the teacher will come with another way of solving that particular thing and

> you as a student you think of something else; and maybe another student is thinking of something. So, the solutions are brought together and then you take the easy way to find that thing."

When asked about brainstorming she said:

> "Yes, it is good. Not only the ways in the book, but different ways of attempting those questions."

Goodwill believed in knowing as many possible ways of solving a problem as possible, so that she could then choose the easiest.

Nkhosinathi often talked in class, but was the kind that believed in keeping quiet for reasons of concentration. When asked if talking during a lesson was helpful he responded by saying:

> "It depends. Most of the time you have to keep quiet and concentrate. If you concentrate you master more things taught by the teacher."

So, Nkhosinathi would talk when he had questions or when responding to the teacher's questions. When he was again asked if talking in class was helpful he said:

> "Talking is really important Sir because it helps when you don't understand some of the things. You have to consult the teacher. We also get different views from different students in class."

During the motivation phase he mentioned correction as the benefit of talking during lessons:

> "It benefits me because when I'm wrong the other students correct me or the teacher corrects me."

When probed about being corrected Nkhosinathi said he liked being corrected. He didn't take it as a bad thing. Maybe that was why Mlungisi always asked through him. His reason for appreciating correction was:

> "When you get correction you know you shouldn't repeat the same mistake the following day."

When he was asked if the motivation method made him talk more than during the pre-motivation phase, he said it made him talk more than before. When their chemistry teacher was asked how often they talked in class compared to phase one he said:

> "Yeah, it's more often. They are more vocal right now. But the thing is the talking is in two forms. You may find that they are talking but the talking is not directed to what the teacher wants. But for now even the direction seems quite well because if someone wants to misbehave, they are the ones who are cleaning up the mess that is being done by this other student."

According to the chemistry teacher his students had improved in their rate of talking in class compared to the time before they were motivated to talk. Their talk was even directed towards the lessons. Moreover, the students were correcting each other when it came to behaviour. On being asked if talking during chemistry was helping his students, the teacher responded this way:

> "Yeah! It does because they are free to discuss things with the teacher. Even if they have something they don't understand they are free to talk. Okay, it's like the environment is very good or suitable for such."

So, the motivation method presented the students with a positive environment for learning purposes. They felt free and welcomed to talk to their teacher about chemistry matters. They would even compete to talk in class:

> “...You find that in most cases they are competing to contribute or to try to answer questions, such that when you pose a question you find that they are more than alert to answer that question. Other than the other time whereby you’d find that you might talk and some other pupils are busy with other things. They are now more attentive in class.”

From this abstract a conclusion was reached that the motivation method indeed had a positive impact on the students. It really motivated the chemistry group to engage very actively in their learning. Even the physics group improved in terms of classroom talk, according to their teacher. They were engaging more with their teacher:

> “The level of communication between myself and the students since introducing that extra credit, it has improved. Not too much but it has shown, there is some visible difference in terms of the communication. The linkage is much better between the students and myself. The method has brought improvement in terms of that situation of communication and wanting to participate in class. I can say that the method is working.”

The physics teacher too noticed the motivation method was really helping his students to engage more in classroom talk than before. But still he felt their engagement in classroom talk wasn’t enough:

> “They don’t talk that much. In most cases I have to be the one who engages them in order for them now to link and communicate with me. Otherwise it even gets to a point whereby if they do not understand the concept no one will actually show and say that ‘Ei, I cannot understand this. They will just let me carry on. Then I will notice that they haven’t heard anything then I move back. Then they’ll start to engage once I start back-tracking from my lesson there. The motivational instrument we’re using there, it helps. They do try now. All be it sometimes the answers, the questioning is not well thought through. But because of that extra mark, they are trying to have that engagement with me as their teacher.”

During a third interview their teacher still confessed that he observed improvement in students engaging in physics lessons, though it was slight:

> "With that new tool that we introduced the activity or rather wanting to engage during lessons it improved slightly in that they would gain extra credits. So, it did help in a way during class, during lessons."

When asked if the motivation method helped in terms of talking, understanding or performance, he said:

> "I think for that one the only aspect it helped in was in just that there was more participation rather than, not necessarily the understanding, but rather the participation increased a bit."

The teacher noticed improvement in answering of questions and he attributed that to active engagement in lessons:

> "Looking at the topics from the last few lessons I will say that it helped in that most of them managed to remember most of the stuff that we did when the tool was introduced. There was just a slight improvement in terms of answering questions there."

The students themselves said it that asking and answering questions in class helped them retain and recall that information better than when they learn passively. The physics teacher was still not impressed about his students' engagement in talk during lessons. They needed the teacher to engage them:

> "They don't talk that much. In most cases I have to be the one who engages them in order for them now to link and communicate with me. Otherwise it even gets to a point whereby if they do not understand the concept no one will actually show and say that 'Ei, I cannot understand this. They will just let me carry on. Then I will notice that they haven't heard anything then I move back. Then they'll start to engage once I start back-tracking from my lesson there."

It seems the physics group had students who were afraid of saying when they had been left behind. But the motivation method was making them talk, though not as expected:

> "The motivation instrument we're using helps. They do try now. All be it sometimes the answers, the questioning is not well thought through. But because of that extra mark, they are trying to have that engagement with me as their teacher."

The physics group seemed to need more time using the motivation instrument so that they would get used to its usage and benefit fully from its application. Their teacher observed slight improvement:

> "With that new tool that we introduced the activity or rather wanting to engage during lessons improved slightly in that they would gain extra credits. So, it did help in a way during class, during lessons. I think the motivation method only helped in that there was more increased participation."

When probed if the participation in classroom talk helped the students, their teacher said:

> "Looking at the topics from the last few lessons I will say that it helped in that most of them managed to remember most of the stuff that we did when the tool was introduced. There was just a slight improvement in terms of answering questions there."

From the abstract it is evident that active engagement in classroom talk helps students in understanding concepts better and in retaining the information for future use.

4.2.1.1.3 Performance

The first question under performance whose responses were to be analysed was:

When given some assignment to do at home do you submit that work on time? Why/why not?

The first time Daluthando was asked this question she said she did not submit her work on time. The reason she gave was that she encountered some difficulties:

> "You find that when I'm given homework to do at home I find some difficulties which I face, which lead me to come back to the teacher to ask."

Daluthando's response was contradictory to the one she gave when she was asked if she ever talked in class. Her response was that in case of difficulties she approached her friends for help, not the teacher. The two responses would mean Daluthando feared being laughed at in class like Mlungisi, but did not have problems approaching the teacher privately. In another interview Daluthando said submission of her work depended on the topic:

> "Yes I submit work on time; but it depends on the topic if I have understood it."

During the last interview of the pre-motivation phase Daluthando said she did not submit her work on time. When probed why she did not submit her work on time her response was:

> "You find that sometimes the questions are very very difficult and I come back to school to the teacher or to my colleagues to seek for help. Then when they have given me the help I attempt the questions and submit."

So, Daluthando was delayed by the difficulties of the questions to submit on time. But finally she would submit. She preferred seeking help from teachers and other students than copying from other students:

> "I don't submit incomplete work. What disturbs us students you find that I did not understand the questions at home, then I come to school early in the morning to copy from my colleagues. I don't like that."

Daluthando submitted work she had done herself, not work she had copied. That was a good habit and showed she wanted to improve in the subject. Tiny too did not submit work when she did not understand:

> “Sometimes I do, sometimes I don’t; especially if I don’t understand that topic.”

Tiny behaved differently from Daluthando in that she never mentioned what efforts she made in case she did not understand some of the questions. She only gave reasons that made her fail to submit or to do the work at times:

> “If I failed to write the homework. Maybe if I didn’t have time I don’t submit on time. But then if I read on time I submit on time. Again if I happen to fall asleep and forget to write the homework or maybe I don’t understand that topic at all.”

Tiny had three main reasons for not submitting her work on time, falling asleep, forgetting and not understanding the concepts asked. During the motivation phase Tiny did not mention excuses for failing to submit assignments. She even appreciated the feedback from the teacher:

> “I benefit from submitting assignments because when the teacher returns the work I see where I went wrong and how I should work that one out.”

She really appreciated assignments because of the teacher’s corrections:

> “Submitting has been helping a lot. I was able to see where I went wrong and what I should do to get back maybe right.”

When asked if submission of assignments and talking were boosting her morale in physics, she said:

> “Yes it has. It has a lot since the more I talk the more points I get and since physics is a bit challenging if ever I get low marks then the 0.5 will make a huge difference.”

During the motivation phase Tiny claimed that she always submitted her assignments for marking by the teacher; unlike during the pre-motivation phase where she would at times not submit because of forgetfulness, falling asleep and poor understanding. One would interpret the punctuality in submission to mean improvement in understanding the subject and in enthusiasm to study the subject. As for Fortune he submitted physics assignments on time. When asked why he submitted on time he said:

> "The teacher always requests us to submit the work on time so that he can see if we understand the topic or not. So that he can try some means to teach us again if we don't understand the topic."

Indeed students' written work is some form of classroom discourse and informs the teacher about the level of understanding of the students in that topic (Tanner, 2009). When Fortune was asked if he found submitting on time helpful he said:

> "Yes. It helps because the teacher will have enough time to prepare himself while he had seen that we don't understand something. So, he will have enough time to prepare, to see how he can make us aware of what we don't understand."

Fortune's main reason was that the teacher was allowed more time to think of other strategies that could make the students understand better. In case Fortune was delayed in submitting his work for marking he apologised to the teacher:

> "I ask for forgiveness from the teacher coz he also will be delayed in planning for other lessons."

Fortune did not consider his side only when looking at things, but even other people. In class he would ask so that other students would benefit too. Even the teacher was considered by Fortune:

> "I submit on time for the teacher to be able to prepare the next chapter to teach us so that he cannot be delayed. Because if I don't submit he will not be able to continue because he didn't see whether we understand the topic or not."

Fortune's claim that their teacher didn't continue teaching new concepts on discovering they had been left behind, concurred with what their physics teacher had already said that he would indeed go back to track where they had been left behind. He was a considerate teacher. Even during the motivation phase Fortune maintained that he submitted his assignments on time, so that the teacher would have plenty of time to mark their work and assess their performance.

Like Fortune, Mlungisi always submitted his assignments. He submitted as early as possible to avoid the temptation of copying from other students:

> "It helps you to test yourself if you know because if you submit later, maybe others have already written and their work is already marked. So, it may happen that you see their exercise books and you copy. So, it is wise to write your own thing as early as possible, so that you cannot be tempted to other people's work."

Mlungisi seemed to believe in himself. He did not believe in submitting copied work. When he was asked for a reason for submitting his work in time, during a second interview, this is how he responded:

> "I'm a person who does not want to be followed after. I'm a responsible someone."

So, Mlungisi was a shy but responsible student. When he was asked about feedback from the teacher in case it delayed, he said:

> "I don't have any problem because I understand that the teacher maybe is busy with something else, that's why the feedback delayed. So, I accept it."

He too was considerate of the teacher's responsibilities, just like Fortune. On being asked again if early submission helped him he said:

> "Yes Sir... It helped me because there are other students in class who when I submit want to copy. I may find that their work is not the same as mine and decide to copy their work.

> It is good that I submit my own work so that I can see the mistakes and the part that I'm weak on, than submitting very late."

When Mlungisi was asked if submitting in time contributed to test performance, he responded this way:

> "It has had some contribution because when I submit my work early the teacher is able to spot my problems. He used to call me individually and explain more so that next time I don't repeat the same mistakes. So, I gain experience when coming to the test because I have work explained."

Mlungisi was called by his teacher for individual attention; something that would be very difficult for the teacher to do to a group of about forty students within forty minutes or eighty minutes. As someone who was shy to talk in class individual attention outside class really helped Mlungisi to catch up with the group on certain concepts he found challenging. As for Goodwill she submitted her work in time and she believed that was part of the responsibilities of a student:

> "I think the main purpose of coming to school is to do what the teacher says. And if I'm doing the homework, I'm helping myself."

Goodwill believed by doing assignments and submitting them in time she was helping herself – a sign of owning the learning and of being self-driven. When probed as to why she thought she was helping herself and not the next person, she said:

> "Not the next person because I get to find out if I've mastered the information or not."

She could only be delayed by difficulties in understanding questions or in finding the information by herself:

> "I submit my assignments, but I've got a problem when maybe I haven't understood a question or I've failed to find information on my own. I decide not to write maybe that question and go to ask the teacher, then I write that question."

When probed about the assignments if they were helpful, she said:

> "They are very helpful because when you're used to these assignments you don't have many hardships when it comes to examination because in the examination they use to ask questions like that. And if you've got, maybe you know the formula and you substitute because you are used to those things."

So, Goodwill valued assignments because they familiarised her with examination questions. Her resources at home were a textbook published by McMillan and the internet:

> "I do my homework at home. What I can say here at school they offered me a chemistry book, this book called McMillan. Yes. I got that book, but if I don't find the information I go to the library. They have just borrowed me a laboratory handbook. I use it at home and because now, in our days parents have provided us with these smart phones things, so we use the bundles to get in the internet and download some of the information."

At school she was not lazy to do her work too, she visited the library for information. At home she accessed more information using her smart phone. To her the phone was not only for social purposes but also for studies:

> "Internet is no longer all about having fun with our friends. It is so helpful even in our studies. I Google information until I get what I want."

Goodwill always went back to the teacher for guidance in case she encountered difficulties while doing her homework:

> "I submit, especially if the teacher gives us the assignment maybe the last period in our class and he says we must submit the homework tomorrow morning. I submit. If I'm not done I go straight to the teacher and say 'teacher I didn't write this question'. Maybe I didn't write question 1 (e) it is because this question was so difficult for me. I tried, here

are my answers. Please give me a guide if it is correct or not. And if not correct what can I do? I want the guide to answer that question."

Goodwill was probed about her desire to succeed in chemistry:

"I like chemistry a lot. I like the new discoveries of things."

On the other hand Nkhosinathi delayed submission of his work:

"I delay since I have to consult other colleagues to help me."

He was unlike Mlungisi and Goodwill who believed in themselves. On encountering difficulties with their work they only consulted the teacher, not other students. Nkhosinathi's delays did not mean submission after the deadline, but meant he would submit on time, not early as others would. He valued submitting on time:

"It is important to submit on time so that the teacher will realise early if we don't understand some of the questions, and come back to revise with the whole class."

In another interview he said:

"I want to make sure that my work has been marked by the teacher and do some corrections as early as possible. It helps you to see where you're lacking and go to approach other students to solve that issue as early Sir."

After getting feedback from the teacher Nkhosinathi would revise his work and make corrections as soon as possible. He would not wait for test or examination time to revise and start making corrections. During the motivation phase of data collection Nkhosinathi improved from submitting on time to submitting in time:

"I submit in time before the teacher asks for the work."

When he was asked for the benefit of submitting early he said:

> "That is helpful because I get more time with the teacher. It helps me a lot because I get the special attention from the teacher."

So, the students enjoyed getting special attention from their teachers because their academic difficulties were solved. The motivation method seemed to have motivated Nkhosinathi to do and submit his assignments earlier than the deadline. Submission of assignments makes students realise their mistakes:

> "That helps because the teacher makes corrections then you realise what you've done wrong."

The teachers were asked one question during the pre-motivation phase which concerned assignments. The question was:

When your students have been given some chemistry/physics work to do at home do they observe submission deadlines?

The chemistry teacher noticed that only a minority of his group was submitting work for marking during the pre-motivation phase:

> "Some of them do, but the majority of them don't. Especially you find that it goes to an extent that you have to go for the exercise books in class so that you can mark them."

So, voluntary submission was rare among the chemistry group before motivation. When asked how quick he gave the students feedback on submitted work, the teacher said:

> "Sometimes it's immediately, but in most cases you find that it's after sometime, because we meet once or twice a week."

The frequency of meeting the students caused them to ask for feedback from the teacher in case of a delay:

> "I think it has a great effect because if you happen not to submit the work immediately the students themselves ask for the work. They usually remind you that you're still owing them some work; that they need to get the feedback from you."

So, those that would submit their work for marking would start demanding feedback from their teacher – a sign of being concerned. Here is what their teacher said about the effect of delayed feedback:

> "I think it has some negative effect in that you find that they are pushing that we should give them the feedback because they are eager to know what is going on in terms of what they have written."

Submission of assignments continued to be a challenge among the chemistry students throughout the pre-motivation phase. Their teacher said reasons they gave for not submitting their work were simple ones like forgetting to do the work. Of course, students like Tiny said that at times she would forget to do her homework and go to sleep. Immediate feedback motivated students, especially positive feedback:

> "Quick feedback makes them even more motivated because if they get the feedback, especially if it's positive feedback, then they feel that they can do things."

With the physics group matters were even worse when it came to submission of assignments:

> "That is the biggest problem I'm faced with. They hardly ever submit the work. So, that is another thing that I think counts to the poor performances in that they do not do any of the homeworks given, those set work for them. So, it is even hard for me to gauge as to how much they really know. So, they never hold on to a deadline."

The teacher stressed the seriousness of the problem of failing to submit assignments by saying they do not do any of the homework. According to the teacher the group was a real hard nut to crack. The physics teacher gave his students feedback immediately, but he would be disappointed by the small number that would bother to do and submit the work:

> "Well, I don't know if I can measure how much it helps because of the fact that sometimes, most of the time actually, you find that they did not even bother themselves to do the work. So, basically it's me coming into the lesson to actually do for them the work they were supposed to do at home. So, it is always me. About 10 % of the class will do the work, and for that little 10% they do try."

Even during our second interview the teacher still faced the problem of having to force his students to submit physics work:

> "So far that's the biggest problem, submission of work. Most of the time they would do it once you've promised some punishment or something. But there is that minority that does submit in time. But all in all that is still the biggest problem I'm facing."

Seemingly, punishment was the language most of the students understood – operant conditioning (Louw & Edwards, 2010). For the few serious students their efforts paid since their teacher observed improvement in their understanding:

> "... another problem with my students is that they really don't give themselves time beyond the classroom to do the work. So, those that do give themselves time beyond the classroom hours; those ones there is a big improvement. You can see the changes that they do understand the work."

Those that submitted because of punishment copied from the few that were serious. That worried their teacher:

> "Most of the work you can see that it's the type of work that only one student does and then the rest will come and seek for assistance if I may call it that. So, you can see that some of them they did not all even give themselves time to actually think through that this is what I'm doing. Do I have even the understanding? So, that is why I'm saying there is that minority that will actually give themselves time to do the work; and then the rest of the usual suspects that will then come and try to copy from those few individuals."

The last question for the students addressing performance during phase one of data collection was:

> How can your performance in chemistry/physics be improved?

When Daluthando was asked this question for the first time she did some introspection. She confessed her wrong doings of not paying attention to the teacher and failing to do physics assignments:

> "By listening when the teacher is teaching and doing assignments which he gives us."

During a second interview Daluthando mentioned group discussions in addition to the previous ways of improving her performance in physics:

> "By being involved in group discussions with my colleagues, listening to the teacher when he is teaching in the class, and doing the work he gives us as students."

During the last interview of the pre-motivation phase Daluthando added an advantage of brainstorming:

> "By forming discussion groups with my colleagues. It is very important because some of my colleagues can come with different answers or solutions which I do not have in my mind."

Daluthando mentioned an advantage of collaborative learning that when working in groups members come up with new ideas. During the second phase of data collection Daluthando cited doing lots of work as one of the methods that could improve her performance in physics. In another interview she said:

> “By researching the things which are hard to me; by listening to the teacher when he is teaching; and by seeking help from my colleagues because I’m not scared of them. Lastly, by forming study groups.”

The motivation method seemed to have motivated Daluthando because she seemed to be more concerned about her progress. She mentioned doing research on the things she found challenging. She had begun owning the learning process. She had even realised that the teacher had to give them more physics work, and by doing corrections:

> “By giving us more homeworks and doing corrections when he has given us difficult work, and doing examples of my own.”

Doing examples of her own would help Daluthando develop the skill of self-explanation (Ionas et al., 2012). Self-explanations help students synthesise new knowledge through relating knowledge they already possess to new concepts. Tiny, just like Daluthando mentioned group discussions and group work as ways that she thought would improve her performance in physics:

> “I guess group work, discussions and stuff.”

In another interview Tiny mentioned a private tutor as someone who could help her do better in physics:

> “I guess by having a private tutor or group discussions.”

A private tutor would be a good facilitator of the learning process since the tutee would get all the attention. Scaffolding would assist Tiny with the calculations involved in physics problems. In another interview she mentioned practice as an act that would improve her performance:

> “I guess by practising.”

Indeed practice makes perfect. Doing her own examples in addition to the work given by the teacher would help Tiny understand physics concepts better. She would develop self-explanations. She even mentioned study groups as helpful towards making her perform better in physics:

> "I think a study group can help me a lot. In fact it is helping."

So, by that time Tiny was a member of a study group and that was helping her improve in her physics performance. During the motivation phase she suggested that if the calculations could be made much easier she would improve in physics:

> "I guess if the calculations could be made much easier than the ones we have now."

Tiny's comment meant she did not intend furthering in physics because the calculations would get more complicated with advanced physics concepts. She also suggested afternoon classes as well:

> "I think afternoon classes can help, coz that's where we're open to say our difficulties we have and we can work on them as a group; with the help of the teachers though, not just we students alone."

The issue of being open to say their difficulties during afternoon classes was a good one and would make her improve in physics. The teacher would be there merely to facilitate the learning process. Fortune thought if his classmates would be disciplined for noise then he would concentrate better and thus perform better:

> "I think it will be better maybe to apply certain discipline to all the students because they sometimes don't listen to the teacher, or they will be telling some news while the teacher is teaching. So, it will be better if the teacher can discipline them so that they always concentrate to the teacher. That way they will pass the subject because physical science needs concentration and a lot of practice. Maybe if the teachers can organise some more work to be done by us we can pass the subject."

Like the other students Fortune noted that concentration and lots of practice were needed for improved performance in physical science. He also added group work as another requirement for better performance in physical science. During the last interview of the pre-motivation phase he mentioned self-commitment as another important characteristic for better performance in physics:

> "I think self-commitment can improve the results in physics and we as students if we can form some groups and work together. Our results can improve."

Fortune did some introspection and realised that he needed to be a self-regulated student. Self-regulated behaviour is characterised by aspects such as self-observation, self-assessment and self-reinforcement (Bandura, 1986). In our last interview he mentioned the attributes of self-regulated behaviour that they could help him improve in physics:

> "I think if I can do more work, more homeworks, more talking in class, more group works. By that way I can be able to master all the formulas in the subject."

Mlungisi mentioned time that if they could have more time learning chemistry then that could help him improve in the subject. He said it in the language of periods that their chemistry periods were fewer per teaching cycle:

> "It can be made better by increasing the number of periods in our timetable because we have only three per six-day cycle. So, when the teacher comes today maybe he will come again next week Tuesday, and you find that you've forgotten what you were learning in the previous lesson."

Mlungisi mentioned the issue of spreading of chemistry periods as a deterrent to their learning of the subject. The periods were very few looking at the six-day cycle and spread far apart, with only one single period and one double period. So, several processes of classical conditioning were involved here such as reinforcement, response acquisition, extinction, spontaneous recovery and generalisation (Watson, 2013). He complained that between the chemistry periods there would be too many other subjects which were demanding too. So, even if they would do the chemistry at home they would end up forgetting the content.

So, Mlungisi had only one worry (the number of chemistry periods) which he said if it could be attended to then his performance would improve. Goodwill mentioned several ways through which she thought her performance would improve such as using the library, science textbooks, past examination booklets and talking to science teachers. She thought even engaging actively in chemistry experiments could help improve her performance in chemistry. A positive attitude towards the subject would also help:

> "I've just observed that many people have a bad attitude towards chemistry. They say chemistry is tough; chemistry is going to be done well by the brilliant student. No, it's not like that. You have to like the subject. Don't have a bad attitude towards it. Study it, work hard. Try."

She believed hard work and persistence would help a student improve in academic performance. Goodwill thought copying of assignments from other students had to be avoided by students. Copying resulted in students having superficial understanding of concepts (Tanner & Allen, 2005). When probed about the importance of relying on oneself Goodwill said:

> "Yes, and doing a follow up. If you don't understand you go to your teacher you ask, or any science teacher."

Goodwill also thought her performance, and that of other chemistry students, could improve if there could be a separate chemistry book with practice questions. Unlike the present situation where the physical science textbook had both chemistry and physics together in one book. Nkhosinathi thought seeking help when he did not understand helped him to improve in chemistry. He also thought extra classes would help the school. By extra classes Nkhosinathi meant lessons conducted outside school hours. During the motivation phase Nkhosinathi thought if teachers of other subjects, such as mathematics and biology, could adopt the motivation method then the school could get better results at the end of the year.

The teachers too were interviewed about strategies that could improve the performance of their students. The interview question was:

In your view what strategies can improve student performance in chemistry/physics?

The chemistry teacher felt science teachers had to conduct their lessons in science laboratories since students felt science laboratories were the right places for science lessons. The teachers also felt science experiments excited students and teachers had to do more experiments, with the students taking part:

> "I think in most cases we need to conduct lessons maybe in the lab because they feel like this is a science subject. So, when they are in the lab they feel like this is the right place to be, and even the experiment you find that you're able to do more experiments there and if you're doing the experiments with them they are sometimes excited. But you find that some of them they try to sit back."

Some of the student participants mentioned the issue of experiments that they motivated the students to learn the subject. Science laboratories are meant for experiments and the storerooms for chemicals and equipment are within or next to the laboratories. So, there is no need for teachers to carry chemicals and equipment all the way to the classrooms, which is cumbersome. Teachers in that way can do as many experiments as possible. The science laboratory set up is also appealing to students and that is what excites them. The experiments help when a concept is too abstract or even challenging to the teacher to explain:

> "I think we need to have more of the practicals, especially on those topics that are a little bit very (what do you call it) abstract. Such that you cannot explain and they get the concept. So, you need to make sure that they see some of the things happen."

The teacher also mentioned the use of models in case experiments could be conducted:

> "Sometimes they need models if you cannot do it in the, if you cannot demonstrate it in class. Or if it cannot be done practically. So, if there are models then it is best to, to show them how it works."

Models assist the brain when visualising some of the abstract concepts. Experiments motivated the students to learn the subject and they wanted to be hands-on:

> "Yes. It makes them even more motivated because some of them even ask to partake in dangerous demonstrations; like maybe reacting alkali metals and other things. So, they become very excited when they see things happen."

The physics teacher felt the physics students needed to be encouraged now and again that they could pass the subject; it was not impossible as he observed some of them to be viewing it as very difficult. He also solved problems with them in class on the chalkboard; as a way of instilling a positive attitude in them about the subject. During the motivation phase of data collection the students were asked a question about their performance. The question was:

> How is your performance in chemistry/physics?

Goodwill noticed improvement in her performance since the introduction of the motivation method. She attributed her improvement to concentration during lessons and submission of assignments:

> "I can say my performance is better now. It's not like the first time I started chemistry. At first I felt like chemistry was very hard for me. I thought of giving up. But now I enjoy it and I concentrate in class. What I like most is that we learn about current things that even most of our scientists are worried about. So, I now focus and I write my assignments. What helps me most is the submitting of assignments because when the exercise books are returned you can see what was hard for you and what you have mastered correct and you are able to do your corrections."

Goodwill did not give up on chemistry during the first few days when she found the subject hard. The current and controversial issues they were learning in chemistry developed interest in her for the subject. She was also challenged by the terms used in chemistry and frightened by rumours that chemistry was hard:

> "Yes my performance is improving. At first it was a very challenging subject because there are these scientific names that it was my first time to hear of or just to see. So, I was wondering 'what's the meaning of these words? Am I going to make it?' and I had just heard some rumours people saying that 'Ah! Chemistry is challenging, chemistry is bad.' But I haven't seen that so far."

Mlungisi observed fluctuations in his performance:

> "My performance is quite good Sir. But sometimes it fluctuates."

When asked for the cause of the fluctuations he said:

> "Sometimes it is caused by the topics. So, some of the topics are quite difficult, but not that much. So, the understanding may not be the same."

Indeed understanding of topics or concepts by a student may not be the same. Some topics or concepts will be found to be easier than others. After a test Mlungisi observed improvement in his performance:

> "So, the performance was much better in this test because in the previous tests I got 80 and 85. So, in this last test I got 90. So, I've improved Sir."

Seemingly, Mlungisi's performance was improving steadily even though he claimed it was fluctuating. One could observe a steady increase of 5% in each test (see Table 4.2). When he was asked if the improvement was caused by the motivation method, he said:

> "Yes Sir, because in the test I remembered everything that we did in class practically. So, the motivational method helped me very much Sir in remembering even tricky things, because we have done these things practically."

So, the chemistry teacher paired the motivation method with teaching methods which motivated students to learn science such as experiments. Nkhosinathi too noticed improvement in his performance:

> "I'm doing well so far."

When asked if performance had improved compared to during the pre-motivation phase he said:

> "It has improved because my marks are increasing."

So, it seemed the motivation method was helping the students to achieve better results. In another interview Nkhosinathi said his understanding too was improving:

> "In terms of understanding the subject I'm improving."

Improvement of marks and understanding in a subject can be indicators of being motivated to learn the subject. Therefore, the motivation method seemed to have motivated Nkhosinathi to learn chemistry. After writing a physical science examination paper Nkhosinathi predicted he was going to do better than he had done in tests:

> "I think I'll do much better than I've been doing in my tests."

Better performance in an examination paper than in tests could have been a true reflection of a dedicated and motivated student. Fortune was another student who observed improvement in his performance:

> "It is quite improving than before."

When asked for the reason for his improvement Fortune said:

> "I think the reason is that our teacher gives us more work and the chance to work in groups so that we understand everything better."

So, Fortune attributed his better performance to cooperative teaching strategies the teacher used together with the motivation method. Daluthando too reported improvement in her performance in physics. Lastly, Tiny too improved in understanding and talking during lessons:

> "I think it's working coz the more we talk, in fact it gives us the energy to talk so that we can get the 0.5 mark."

Small as it seemed to be to the students the 0.5 mark encouraged some of the students to engage actively during physics lessons. On being probed about the 0.5 mark that it encouraged them to engage more in physics lessons than before, Tiny said:

> "Yes, of which then we get to understand it better whilst talking."

Their better understanding of the science concepts can be seen from Table 4.2 since their scores for tests and quizzes on average were higher for the motivation phase than for the pre-motivation phase. Even their scores in examination papers also improved (see Table 4.1). Tiny's average scores for the quizzes for the pre-motivation and motivation phases were 62% and 72% respectively; likewise they were 43% and 53%for her tests. For the quizzes Tiny made a 16% improvement between the two phases of data collection, and a 23% improvement in her test scores.

When Tiny was asked to predict her performance after writing a physical science examination paper she responded by saying:

> "Ah, the paper was fine. It's just that the first two questions were a bit challenging. Otherwise the paper was okay. I think the motivation method will contribute because now

I say minus the first two questions, and adding those 0.5% I think they'll make a great difference."

So, Tiny found the examination paper manageable because of the motivation method. Indeed, Tiny performed better in her final examination papers (Papers 1 and 2) compared to her performance during the mock examination (see Table 4.1), which was written during the pre-motivation phase. In fact all the participants did better, on average, in the papers they sat for during the motivation phase as compared to those they sat for during the pre-motivation phase. Even Daluthando improved, though all her scores were below the pass mark (50%). Indeed the 0.5% motivation marks made a difference to all the participants' final scores (see Table 4.3).

Table 4.1 Tabulated scores of mock and final examinations

Physical Science Components	**Student names**	**Pre-motivation Phase: Mock Examination**		**Motivation Phase: Final Examination**	
		Paper 1	**Paper 2**	**Paper 1**	**Paper 2**
Chemistry	Goodwill	54	52	61	56
	Nkhosinathi	40	58	53	50
	Mlungisi	75	88	93	80
Physics	Tiny	31	39	56	51
	Daluthando	21	33	46	48
	Fortune	41	45	64	61

The physical science teachers were asked a similar question during phase one and it was:

How is their performance in chemistry/physics?

The question above was followed by another question during phase one which related to performance and motivation:

How quick do you give them feedback on submitted chemistry/physics work? What effect does the feedback have on student motivation and understanding?

According to the chemistry teacher his group was performing well even before the motivation method was used with them:

"So far they are performing well."

When interviewed about feedback and its effect he said:

"Usually it's immediately or after two or three days because of the fact that we meet once or twice a week. I think it has more negative effect in that you find that they are pushing that we should give them the feedback because they are eager to know what is going on in terms of what they have written."

The chemistry group seemed to have been a motivated group because after submitting they would do a follow-up on their performance. They were a group of self-regulated students. Another advantage of giving students feedback quickly the teacher gave was:

"It is helpful in that it makes them even more motivated because if they get the feedback, especially if it's positive feedback, then they feel that they can do things."

So, positive feedback empowers students academically. The physics teacher had a demotivated group and their performance was not so good:

"The performance is not so good. It's, I can say at this point it is below average. It is not good in that they lack the motivation for the subject."

Like the chemistry teacher, the physics teacher gave his students feedback on submitted work as soon as he met them for the next physics lesson. The effect of prompt return of student work seemed to help only those few that submitted their work:

> "Well, I don't know if I can measure how much it helps because of the fact that sometimes, most of the time actually, you find that they did not even bother themselves to do the work. So, basically it's me coming into the lesson to actually do for them the work they were supposed to do at home. So, it is always me. About ten percent of the class will do the work, and for that little ten percent they do try. So (shrugging of shoulders and silence).

The shrugging of shoulders by the teacher could have been a sign of despair. The teacher could have lost hope with some of the students. So, the teacher's feedback and revision only helped a very small percentage of the students, especially those that submitted their work for marking. But things changed later. The teacher started noticing improvement in the behaviour of the students:

> "Well, lately they have been improving a lot. I think that something somehow is working. They are doing the work. There is some slight improvement in that they do try to, even if there are some difficulties, some of them they do now give themselves time to actually come and ask questions pertaining to the work."

Some of the students became serious with their school work and the teacher noticed improvement in their understanding of the science concepts:

> "The effects of feedback to some or at least those that, because another problem with my students is that they really really don't give themselves time beyond the classroom to do the work. So, those that do give themselves time beyond the classroom hours; those ones there is a big improvement. You can see the changes that they do understand the work."

The physics group seemed to be showing very little improvement during data collection. However, on analysing the examination scores at the end of data collection for both examinations sat by the groups, the physics group benefitted from the motivation method much more (55%) than the chemistry group (7%).The next question to be addressed was asked during the motivation phase and was:

> In your view has student performance improved compared to phase one?

During the first interview of phase two the chemistry teacher reported improvement among his students:

> "Yeah, it has great improvement."

The teacher reported improvement in the performance of his students even during the pre-motivation phase. But during the motivation phase he noticed even greater improvement. Even their test scores (Table 4.2) on average showed an improvement of 30% between the two phases of data collection:

> "... I was looking at the test, I guess looking at the test they are, the majority have passed and this is a topic that usually gives them some problem because it's stoichiometry. Sometimes stoichiometry is a little bit tricky. But for them it was, the way they learned it, it was interesting and at the same time the results are marvellous."

The students themselves reported that they had heard rumours that stoichiometry was a very difficult topic, but to their surprise they enjoyed the topic and passed it well. So, the teaching methods, together with the motivation method, motivated the students to appreciate their learning and thus found it interesting and manageable. The improvement was observed even in their examination scores (see Table 4.1):

> "Their performance in the examination improved although it is not that much; but there is some form of improvement."

With the physics teacher some students showed improvement, others did not:

> "For some, for those few individuals, some of them have improved quite a lot. But I think maybe that is due to the fact that we're nearing the end of the year. Maybe they are starting to see the importance of doing well in the subject. But in general terms some people are just still not showing any improvement at all."

Even during a second interview the teacher reported slight improvement among some of those students:

> "At this point with that motivational instrument we are currently using, it has slightly made a difference. All be it not that significant but it has made a difference in that some of them are starting to notice that they need to push hard to get that, those, to improve their marks."

So, the physics students were one by one realising the importance of improving their performance in the subject. Their low examination scores shadowed the great percentage improvement they made from the twenties, thirties and forties they scored during the mock examination, to the forties, fifties and sixties they scored during the final examination (refer to Table 4.1). In fact the physics students showed a much better percentage improvement in their examination scores between the two phases (55%) than the chemistry group (7%). The last question under performance was:

> Do they ask for more work than you give them?

The chemistry teacher reported that some of his students asked for extra work after completing classwork:

> "Yes they do. But in most cases when I teach them I give them some classwork. Then when we do those classwork you might find that I've given them one or two questions, then you find that some of them may want more of the practice."

The students asked for more work and were eager to do more than before the motivation phase:

> "Yes they do. The difference is not that much but they do. Because they are eager to do more work than before."

The physics teacher came with a different report, his students were not asking for more work:

> “At this point they do not ask for more work. They don’t ask for more work at this point. Nothing in terms of work load. Nothing has changed.”

During a second interview the teacher observed that a few students started asking him questions from time to time:

> “Only a very very limited few will from time to time ask those few questions. But I can say that generally they don’t. They do not ask as much as they are supposed to, especially since physics is something that needs you to be alert. When you’re doing physics you need to ask questions. So, the rate that they are asking at is not satisfactory.”

So, the students did not ask for more work but asked a few questions. That was the case with the group throughout. They did not ask for more work from the teacher, they only asked a few questions. Moreover, the questions were asked mostly by boys. The boys were more than the girls in the group:

> “They have not been asking for more work per se, just hints of what might come out in the assessment. But for work just two out of a class of thirty boys tried to ask those few questions.”

The interviews conducted with the students, together with their physical science teachers, revealed that the motivation method in general encouraged the students to engage more in science discourse than before it was employed. Generally the method encouraged the students to talk more in class and to write more science work with better understanding than before.

4.2.1.2 Lesson observation tool

Data from the lesson observation tool was categorised into two for analysis purposes. The categories were oral and behaviours of students.

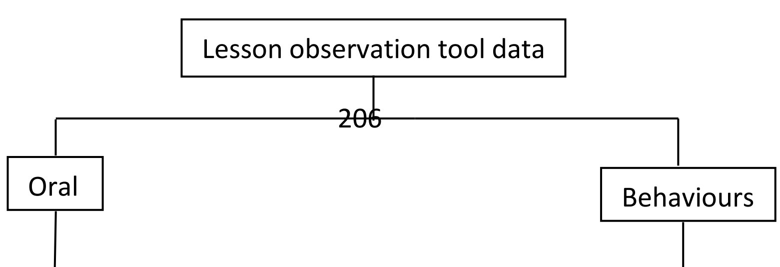


Figure 4.5 Categorisation of data from lesson observation tool

4.2.1.2.1 Oral data

Interactions in the science lesson room were observed and jotted down in the lesson observation tool. Oral data were further grouped into student-student and teacher-student interactions.

4.2.1.2.1.1 Student-student interactions

The students interacted more with each other during laboratory experiments and classroom discussions than during traditional lessons. The physical science teachers engaged their students more in experiments and group discussions during the motivation phase than during the pre-motivation phase. Their interactions during the motivation phase were more about the experiments and topics they were handling than about non-academic matters. The main reason was for them to score those extra marks from their teachers for contributing positively towards the learning activities.

The positive interactions were observed more among the chemistry students than among the physics students. Most of the physics students engaged in other topics covering social issues, even during lessons. Some students were seen reading newspapers, magazines, or debating about other things. But things improved even with the physics group during the motivation phase. The majority would talk about the science activities assigned by the teacher. During the motivation phase, the students would ask each other more open-ended science questions than during the pre-motivation phase where their questions were mostly closed.

4.2.1.2.1.2 Teacher-student interactions

Teacher-student interactions were observed to be more frequent during the motivation phase than during the pre-motivation phase. Again, as with student-student interactions, more student-teacher interactions were observed during chemistry lessons than during physics lessons. The talks were in the form of discussions, questions, suggestions, and answers. Most students were observed talking to the teacher in chemistry than they were in physics. The teachers helped the students to reason through the thinking process. They asked their students both closed and open-ended questions. The open-ended questions sought student understanding, while the closed questions sought facts. It was observed that the students asked the teachers fewer questions than they asked their colleagues. Even during group or class discussions, the students talked more among themselves than with their science teachers.

When the students interacted with their teachers they used proper scientific terms and that proved they were moving away from the proximal end of the continuum of understanding, towards the distal end. Their teachers helped them with even more proper terms and scientific language such that each student’s ZPD was narrowed down (Vygotsky, 1978). More interactions helped the students develop their thinking abilities and processes. The use of proper language was observed more during the motivation phase than during the pre-motivation phase. That was partly because as the students got familiar with the scientific terms, they used them more and more in their classroom discourse. This was observed more among the chemistry students than the physics students. The chemistry teacher commended his students for the use of scientific terms more than the physics teacher commended his, but overall, both teachers improved their students’ attitudes towards science.

4.2.1.2.2 Student behaviours

Student behaviour is closely linked with student attitude towards the subject and teacher. At times student behaviour is shaped by classroom management practices. With the chemistry group, most of the students displayed good behaviour that supported the teaching/learning atmosphere. The physics group, on the other hand, had many students that displayed bad behaviour, which did not support the teaching/learning atmosphere. Some would arrive late for lessons (even fifteen minutes late) and a few boys would not attend some physics lessons (for undisclosed reasons). Such misbehaviour caused slight tension among the students, especially between the boys and the physics teacher. The bad behaviour was common during the pre-motivation phase of data collection and rare during the motivation phase. The bad behaviour of the physics students also resulted in poor performance in tests (see Table 4.2).

Table 4.2 Tabulated scores from quizzes and tests

Physical science components	**Student names**	**Pre-motivation phase**				**Motivation phase**			
		Quizzes		**Tests**		**Quizzes**		**Tests**	
		1	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Chemistry	Goodwill	80	84	45	58	80	90	65	73
	Nkhosinathi	72	85	35	48	78	85	59	65
	Mlungisi	80	85	70	80	85	95	85	90
Physics	Tiny	56	68	40	45	68	76	46	60
	Daluthando	52	65	35	42	63	72	40	56
	Fortune	80	65	45	55	70	90	53	68

Nevertheless, their performance improved during the motivation phase since they started cooperating with their teacher and with each other. The motivation method indeed motivated the physics students to do better in their test scores than before they were motivated. They made a 23% improvement in tests between the two phases of data collection. On the other hand, the chemistry students accomplished 30% improvement in their test scores between the two phases. The quiz scores also were higher, on average, for the motivation phase compared to those for the pre-motivation phase of data collection. The percentage improvement in tests for the two physical science groups combined was 27%.

4.2.1.2.2.1 Attitudes

During the pre-motivation phase, the chemistry group had most of the students engaging actively in lesson activities such as classwork, discussions, and science experiments. During the motivation phase all the students would be on task during lesson activities. They interacted with each other around content issues. Talks about non-academic issues were minimum. However, most of the physics students did not engage actively in lesson activities during the pre-motivation phase. They would be caught off task during lessons and they would talk with each other around non-academic issues. They would be hesitant to engage in academic activities, whereas the chemistry students participated actively in academic activities. Things got better with the physics group during the motivation phase. More students engaged actively in classroom activities, and their scores in written classroom activities improved (see Tables 4.1 and 4.2).

Something observed amongst most of the students was that they sought information to complete assignments. They did not seek clarification for conceptual understanding, and they followed laid down rules when solving problems. Some of the teaching methods encouraged students to find practical ways of solving problems, and to use evidence to support claims. So, during practical sessions, the students were encouraged to collect data and manipulate it for answering questions. They were discouraged from taking measurements or determining facts to answer questions.

Most students complied with classroom/laboratory rules. Only a few did not comply, specifically, the male physics students. The teacher noted the bad attitudes of a few male students who deliberately missed some physics lessons in one of the interviews held with him during the motivation phase. He noticed that most of his students had already given up on physics during the pre-motivation phase, so he motivated them to work even harder in order to pass the subject.

4.2.1.2.2.2 Gestures

Gestures of kindness and good behaviour were awarded marks by the teachers. Gestures worked well for the chemistry group. The physics group behaved like they had not yet grasped the purpose of the motivation method, so, among the physics group only a few students scored 0.5% for gestures compared to the chemistry group. Punctuality was one of the gestures noted by the chemistry teacher. The gestures facilitated classroom management and improved the teaching/learning process.

The chemistry teacher modified the motivation method slightly by withdrawing 0.5% each time a student misbehaved or showed unkindness. The 0.5% was withdrawn from the marks the student had accumulated through the motivation method, not through assigned work. Students lost 0.5% for tardiness, making noise, failure to meet the deadline for submission of work and many more acts of misconduct. What made the exercise interesting was that the students rebuked and corrected each other, so they did not lose motivation points through unbecoming conduct.

Students used relevant scientific terms in their descriptions and explanations. The scientific terms were used more by the students during the motivation phase than the pre-motivation phase, which was an indication that they were becoming more concerned about their education and were dedicated to doing even better in tests and examinations. They would sometimes use everyday discourse, but scientific discourse was the most common. Even their teachers, at times, used everyday discourse, especially when explaining difficult concepts. Difficult concepts were usually those involving abstract matter, such as the structure of an atom and resistance.

The science teachers helped their students move from the use of everyday discourse to scientific discourse through scaffolding and intersubjectivity (McCown et al., 1996). They helped the students learn the language of science (Singteach, 2014). Communication within the classroom helped the science teachers discover misconceptions. The teachers also praised those students who contributed positively towards maintaining a positive learning atmosphere in the classroom or laboratory. The teachers' praises motivated students to try to do better, and, thus, improve in achievement and behaviour. Students were praised more by their science teachers during the motivation phase than during the pre-motivation phase.

Students displayed more kind gestures during the motivation phase in order to score as many marks through the use of kind gestures as possible. Classroom interactions enabled the teachers to locate their students along the continuum of understanding and then help them move towards the distal end of the continuum (see Figure 4.2.2.1). Such academic assistance helped the science students do things they could not previously do on their own – it narrowed their zone of proximal development (ZPD) (Vygotsky, 1978). At times, the science teachers spoke in SiSwati to clarify or explain some difficult concepts to the students, for example, code-switching.

4.2.2 Written interactions

Written interactions comprised students' written work, such as classwork, homework, tests and notes (see Appendix F). Data from the students' written work were analysed according to where the terms used by the students were located along a continuum ranging from everyday terms to scientific terms. The left side of the continuum had everyday terms while the right side of the continuum had scientific terms.

Everyday discourses Scientific discourses

Figure 4.2.2.1 Continuum of terms used by students

The data were also analysed according to the marks scored by the students in their written work (see Tables 4.1 and 4.2). The scores were those obtained in classwork, homework, tests, quizzes and examinations. The scores were rated according to a continuum ranging from low marks (0%) to high marks (100%).

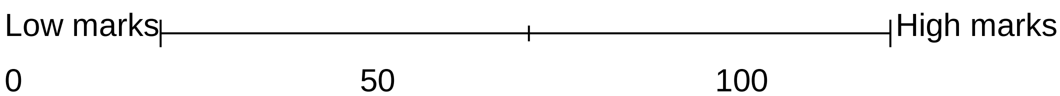


Figure 4.2.2.2 Continuum of student scores

The data were also analysed according to where the terms used by the students were located along the continuum of understanding (see Figure 4.2):

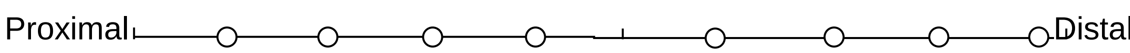


Figure 4.2 Continuum of student understanding

The more scientific the term used by a student, the further the student moved to the right of the continuum since that displayed a better understanding of the concept at hand. The more general the term used by the student, the more proximal the knowledge of the concept possessed by the student appeared along the continuum.

4.2.2.1 Classwork and homework

Classwork and homework were written in the same book and were thus analysed concurrently. The students were given more classwork and homework during the motivation phase than during the pre-motivation phase. The teaching methods used during the motivation phase encouraged the students to appreciate school work and to sometimes ask for even more explanations. This positive attitude towards school work was observed mostly among the chemistry students, however, in the physics group only a few students displayed such an attitude. More chemistry students submitted their work on time than did physics students.

The relevant scientific terms were used more appropriately in classwork as compared to homework. This may be due to students helping each other (intersubjectivity) or their teacher assisting them (scaffolding). Therefore, the work done in class was of better quality than the work done by the students individually at home. That resulted in more students scoring better marks in classwork than in homework. The few students who scored high marks in homework were those that were good in the subject. The quality of the homework by the rest of the students was low because some students would do the work early in the morning at school and rush to submit it. In most cases, their teachers complained that only a few students would take their time at home and answer properly, while the rest would just copy from the others and sometimes even make mistakes.

Classwork and homework were important in that they revealed the students' levels of understanding of the subject, thus allowing their teachers to know where they were lacking and help them accordingly. Even students' misconceptions were exposed by the classwork and homework, and thus students received the correct information before writing tests and sitting examinations. Classwork and homework also gave the students practice and exposed them to different kinds of questions and situations. Feedback from such work helped teachers know the pace at which they had to move in covering the syllabus.

The terms used by the students in classwork and homework were more scientific than the everyday terms. Students just needed assistance here and there, otherwise, textbooks, teachers and friends helped with appropriate terms. A challenge most students faced was properly writing symbols used for scientific concepts, as well as symbols for elements of the periodic table. Chemical formulae and equations were also challenging for some students. Graphs proved to be another challenge for the students. Questions involving graphs were more difficult for students as compared to questions involving written text only. They were challenged by drawing graphs and interpreting them. Students improved through practice.

4.2.2.2 Quizzes and tests

Quizzes and tests made up the class average (CA) of the students, provided teachers marked and recorded them. Quizzes were administered more frequently than tests, usually without any prior notification given to the students. Tests were administered at least twice per term and were written on dates fixed by the teachers. Sometimes, however, the teachers discussed the dates with the students. Tests carried more weight than quizzes and prepared students for examinations. Tests were good gauges of students' mastery of content since the students wrote them without assistance.
Usually, the students' performance decreased as the academic year progressed, but with the use of the motivation method the students kept improving in their quiz and test scores (see Table 4.2). For example, Daluthando scored 56% in her final physics test (Test 2), yet her score for the last test (Test 2) during the pre-motivation phase was 42%, an improvement of 33%. Daluthando was one of the students who found physics difficult because of the calculations involved. Both the physics and chemistry groups improved in their test scores during the motivation phase as compared to the pre-motivation phase. However, the chemistry group showed a more significant improvement of 30% as compared to the physics group's 23%. Overall, both groups combined made an improvement of 27% between the two phases of data collection.

The motivation phase improved not only interactions in the classroom, but also academic achievement (see Table 4.3). One of the students (Nkhosinathi) even suggested that if all the teachers in the school adopted the motivation method, the results of the school in external examinations would improve too.

Table 4.3 Effect of motivation points on student scores

Physical science components	Student names	Motivation points	CA	CA + Motivation points	40% CA	60% Exam	Final scores with motivation points	Final scores without motivation points
Chemistry	Goodwill	7	63	70	28	35	63	60
	Nkhosinathi	7	50	57	23	31	54	51
	Mlungisi	3	82	85	34	51	85	84
Physics	Tiny	7	44	51	20	32	52	50
	Daluthando	5	38	43	17	28	45	43
	Fortune	6	53	59	24	37	61	58

The final physics and chemistry scores of the students represented in Table 4.3 were increased by those points they had scored from the motivation method. The effect of the points from the motivation method was more or less the same for the two groups. On average, the chemistry group improved by 4% while the physics group improved by 5%. Both groups combined improved by 4% on average, considering their final scores which included the motivation points and their final scores which excluded the motivation points.

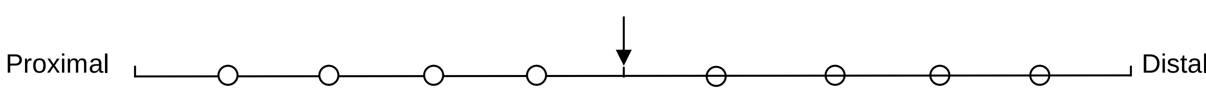
The motivation method elevated some students by one grade. For example, Fortune improved from a grade of D (58%) to a C (61%). So, too, did Daluthando, although she scored below the pass mark of 50%, and improved from a grade of F (43%) to an E (45%). Lastly, Mlungisi maintained a grade of A (from 84% to 85%). The motivation method also increased the self-confidence and self-regulation of the students, and, as a result, remarkably reduced negative behaviour such as copying and reduced during the motivation phase.

4.2.2.3 Examinations

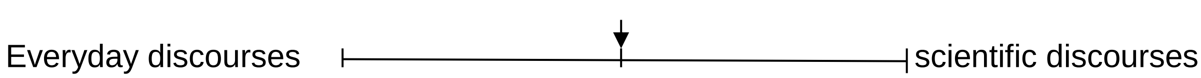
Two examinations were written by the students in the academic year: a mock examination during the pre-motivation phase and a final examination during the motivation phase. There were differences in the performance of the students in physical science in the two examinations. On average, the students performed better in the final examination compared to the mock examination (see Table 4.1). The scores were generally higher and there were more scientific terms used. For instance, Mlungisi scored 83% (with Exam 1 contributing 40% and Exam 2 contributing 60%) in chemistry during the mock examination and 85% in the final examination. In physics, Tiny scored 36% in the mock examination and 53% in the final examination.

Some students showed slight improvement from their mock examination during the final examination. That was commendable since the usual trend was that student performance decreased as the year progressed. The final examination scores for the chemistry group were slightly higher than the mock examination scores; the average percentage increase stood at 7%. However, the average percentage increase for the physics group stood at 55%. Therefore, the motivation method helped the physics group in their final examination far above what their teacher could have imagined.

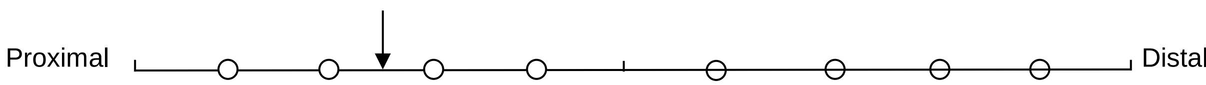
The teachers helped the students with questions where they had to describe and explain. The students' responses showed shallow understanding, so their teachers extended their responses through scaffolding. An example of this could be a question in a chemistry paper where students were asked to explain why a certain element marked in the periodic table was not reactive (see Appendix F). Mlungisi and Goodwill answered that it was because the element was a noble gas, while Nkhosinathi said it was because the element was in Group O and elements in that group were not reactive. Mlungisi and Goodwill's answer could be placed halfway along the continuum of understanding:



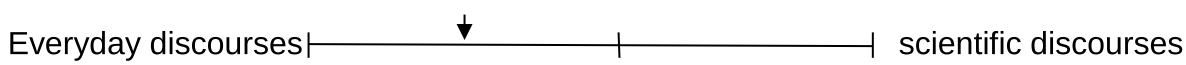
The scientific term Mlungisi and Goodwill used when describing the element means that their answer was also located around the centre of the continuum terms used:



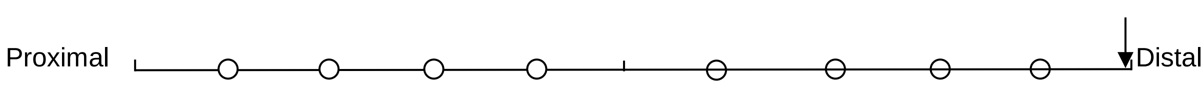
They realised that element X was positioned in Group O of the Periodic Table and was therefore a noble gas, but they did not explain why it was not reactive, as per the requirement of the question. The teacher gave half of the marks to the answer. Nkhosinathi's answer got 0 marks because he only realised the group of the element and failed to answer why it was not reactive. Nkhosinathi's answer could thus be placed close to the left end of the continuum of understanding:



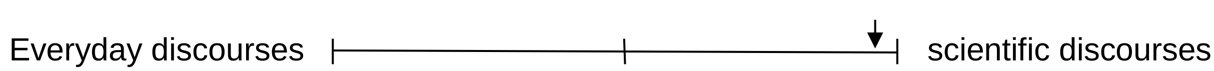
Nkhosinathi also failed to remember the appropriate terms used when describing the Group O elements. The appropriate descriptive terms are noble or inert gases. Therefore, along a continuum of terms used Nkhosinathi's terms can be located close to everyday discourses:



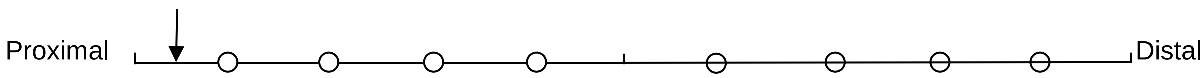
All of the students' answers did not score full marks and were partially correct. The teacher informed them that this was because the element had a full outer shell. As a result, the teacher assisted them to move towards the distal end of the continuum of understanding:



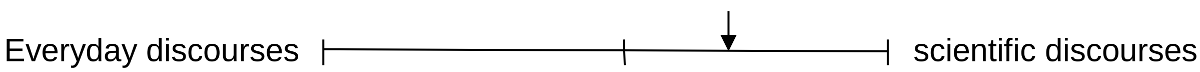
The terms the teacher used during scaffolding lied very close to the right end of the continuum of terms used:



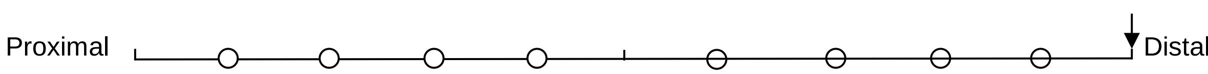
In another question, the students were asked to explain why a diamond did not conduct electricity (Appendix F). Their answers varied from very good to completely wrong. Nkhosinathi's answer to this question was completely wrong. He stated that the diamond did not conduct electricity because it was made up of carbon dioxide and had atoms that did not allow any change. This answer could be placed to the far-left end of the continuum of understanding:



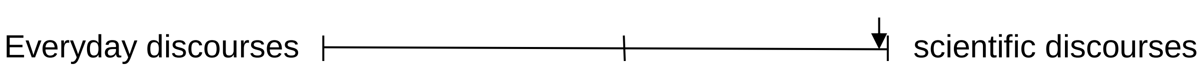
The terms Nkhosinathi used were scientific (carbon dioxide and atoms) but they were the wrong terms to use in the question. Therefore, along a continuum of terms used the location was more scientific:



Mlungisi's answer to the same question was very good. He stated that the diamond did not conduct electricity because each of its carbon atoms was bonded to four other carbon atoms, leaving the diamond with no free electrons to conduct electricity. His answer could be placed on the far right of the continuum of understanding:



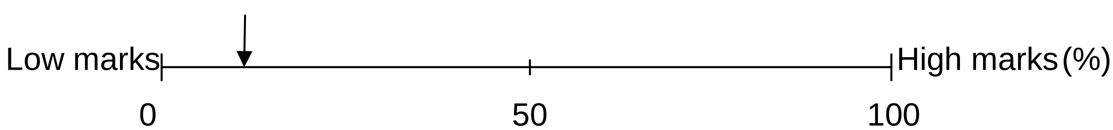
The terms he used were more scientific and lied very close to the right end of the continuum of terms used:



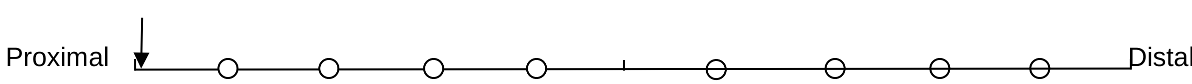
Once more, the teacher assisted the students with the correct answer. The students were challenged most by the questions that needed them to calculate, describe and explain.

They were also challenged by questions involving graphs. Another aspect that challenged the students was remembering and writing the chemical symbols of the elements of the Periodic Table. An example of this is in Appendix F, where Nkhosinathi represented hydrochloric acid as “chl” instead of HCl.

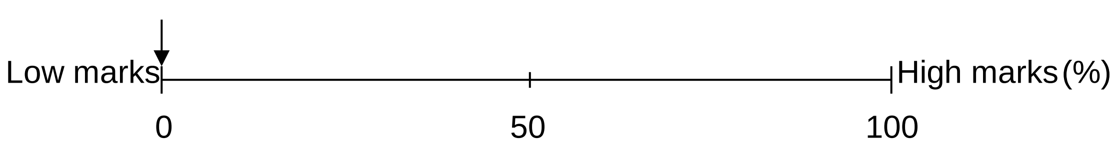
Difficulties with the interpretation of graphs can be seen in question three (Appendix F) where Nkhosinathi almost messed up the whole question. The task was to understand a chromatogram for a urine test. The urine from four athletes was tested for the presence of caffeine and paracetamol. Nkhosinathi’s understanding of that question proved to be very poor, as he scored 0.5 marks out of three marks. His score was very low, at only 17%:



Likewise, Daluthando left a whole question almost blank during the mock examination (question six in Appendix F). In this question, the students were expected to interpret a speed-time graph for a skydiver. In that question she scored zero marks. The students were expected to give explanations to all three parts of the question, and this was something that they all had challenges with. Therefore, Daluthando’s understanding of the question was very poor:



As her score was zero for that question, the continuum looked like this:



A poor understanding of a question after a student has been taught the concepts signifies a poor motivation to learn the subject. After the motivation phase, the examination scores for the physics group were much better and they were not leaving questions unanswered.

4.3 Conclusion

In this chapter, the data collected for the study was analyzed using the thematic discourse analysis approach. The data was interpreted and discussed with reference to the literature reviewed for the study. The reviewed literature was used in supporting or refuting the research results. The data collected using the three different methods of data collection: interviews, documents and lesson observations, all showed that the motivation method improved discourse within the science classroom. The quality and quantity of oral and written discourse improved in physical science. The next chapter summarizes all of the research. It states the conclusions drawn from the research results, the implications of the results, as well as recommendations for future research.

Chapter 5: Findings, Recommendations and Concluding Remarks.

5.1 Introduction

In chapter four the findings of the study were presented, analysed and discussed. Chapter five presents the findings, recommendations and concluding remarks of the study.

Chapter one highlighted the background information of the study. The chapter also addressed the problem statement, the main aim and the objectives of the study, as well as the main and sub-questions guiding the research. Chapter one also outlined the significance of the study. The key concepts used in the study were stated and the main focus of the study was outlined. It also addressed chapter divisions. The study was conducted to answer the following questions:

(a) How does classroom discourse relate to natural science understanding?

(b) What is the effect of external motivation on discourse during natural science lessons?
(c) What is the effect of feedback during natural science learning?
(d) How can feedback be enhanced in the natural science class?
(e) Which teaching strategies improve interactions during natural science learning?

Chapter two analysed the literature reviewed from different sources. It started by giving an overview of the literature reviewed. It analysed student discourse, the language of science, motivation, teaching and learning theories, as well as teaching and learning styles.

Chapter three focused on research methodology. The research aims were restated, and the research design and methods discussed. It covered population and sampling methods, data collection and the motivation method. The chapter also outlined data transcription and analysis as well as credibility. Issues of ethics were also explained.
In chapter four the research data was presented, analysed qualitatively using the thematic discourse analysis method and discussed. A lesson observation tool (Appendix E) and an interview tool (Appendix D) were used for collecting the data. Documents obtained from student participants were also used for data collection.

The present chapter focuses on the overview of the findings, recommendations and concluding remarks in relation to the research questions and objectives.

5.2 Discussion of findings

In this section the findings of the study are discussed with the intention of responding to the main research question and its sub-questions, as stated in chapter one section 1.3. In light of those research questions, the following are the main findings and recommendations of the study:

5.2.1Findings about the main research question and the purpose of the study:

Can student motivation enhance classroom discourse and improve natural science understanding?

During the pre-motivation stage of data collection, some of the participants complained about mathematical calculations. They claimed calculations made the subject difficult. However, during the motivation phase of data collection there were no complaints about mathematical calculations. Instead, students understood their science work better, especially in chemistry. This motivation developed the students' interest in the subject. Instead of cramming formulae, which made the subject seem difficult for them, they sought mastery of the subject matter and understood it better.

The motivation method encouraged the students to talk more in class during natural science lessons. As they contributed more by talking, they developed an interest in learning scientific concepts and they gained better understanding of the concepts – perhaps through self-explanations. They even developed an interest in the subject. The teaching strategies the natural science teachers adopted during the motivation phase encouraged the students to interact more during science lessons. Most of the students ended up being self-regulated. They appreciated the question-answer aspects of their science lessons; as opposed to their behaviour before the motivation phase where their physics teacher would end up answering his questions himself.

Poor or low performance disappointed the students during the pre-motivation phase. However, during the motivation phase their scores were better and that boosted their morale to work harder and gain a better understanding of the content. A low score during the motivation phase did not make the students give up on the subject, and they worked even harder to have a better understanding and good marks. The students developed even more interest in experiments or practical work than they previously had during the pre-motivation phase.

The motivation method encouraged students to seek explanations in cases of misunderstandings. It made them realise gaps in their understanding of scientific concepts; and thus developed the interest to close those gaps through reading and writing more, and through self-explanations. Before exposure to the motivation method, most of the students would just copy solutions from their friends without asking for explanations. They did this just to submit their work and escape any form of punishment the teacher had threatened them with. Seeking help, especially from their science teachers, informed their teachers about their misconceptions and difficulties. Their teachers would then decide on better or varied strategies to employ to make them understand better (ZPD), individually or as a class. Such care or attention cultivated confidence among the students to ask for help in case they did not understand certain concepts. The motivated students kept working hard in the subject.

The motivation method made science lessons interesting to all. It made the students and their science teachers talk more during science lessons. This developed the students' interest and enhanced class discussions. The students even developed self-discipline and their science teachers did not have classroom management challenges. The method improved their moral standards and the students cooperated very well with everyone in the classroom. This led to a conducive teaching/learning atmosphere. Even the difficult students were gradually changed by the motivation method and they wanted to participate in the natural science lessons. As a result, they ended up developing the desire to understand science concepts.

During the pre-motivation phase of data collection, some students did not appreciate teacher talk and wanted to be given lots of notes instead. That changed during the motivation phase. They engaged more in classroom talk and asked their science teachers more questions. They realised that more talking in class assisted them with recalling those concepts during tests and examinations.

The fear of talking with other students disappeared from the shy ones. They would make every effort to get those extra points during lessons. The varying of teaching strategies helped reserved or shy students contribute actively during activities such as group discussions. In fact, talking is an active cognitive process because it involves the processing of information and that leads to understanding. During lessons, verbal corrections made students master the content and they avoided repeating those mistakes. Some of the students even laughed at their colleagues and this was a very powerful tool that made them avoid making a mistake again. Also, the teacher's correction would not be forgotten so quickly. Laughter from the other students discouraged the shy students from contributing in class during the pre-motivation phase. However, during the motivation phase such laughter encouraged the shy students to argue their contribution with supporting evidence, so that they would score those extra marks from their science teacher.

During the motivation phase students discussed topics amongst themselves for mutual benefit. Introverted students benefitted the most. The motivation method boosted their confidence when talking in the midst of their colleagues. The main aim of these discussions was to score extra marks and also understand better; such discussions allowed science teachers to delve deeper into concepts.

For students to contribute effectively to the discussions, either by asking or answering questions or through gestures such as cleaning the chalkboard for the teacher, they had to concentrate in class. Interaction with the teacher and classmates piqued students' interest in the concepts. In that way the students improved their understanding of scientific concepts. Concentration led to relevant contributions, and that improved the pace of the lesson, meaning better syllabus coverage.

Teachers were able to give students clear explanations, because students were open about their conceptual challenges. Some students even debated with their science teachers during the motivation phase. There were more constructive arguments during the motivation phase compared to the pre-motivation phase. During the pre-motivation phase some arguments tended to be more disorderly as opposed to constructive. Classroom debates are useful in exposing the students' levels of understanding.

Debates challenge students and teachers to read more in order to contribute constructively during debates. Debates also expose students to other perspectives. Students are able to learn from each other during debates by brainstorming together.

Recommendations

In view of the many challenges faced by demotivated high school natural science students in Swaziland, the following recommendations were made:

- To overcome the phobia for mathematical calculations in physical science, especially in physics, inter-curricula planning between physical science teachers and mathematics teachers had to be adopted; this worked for mathematics and science teachers in the US (Gleason, Berg & Huang, 2018). The students needed to be trained to master mathematics so that they would not find the mathematical calculations they found in physical science challenging. Natural science students had to be discouraged from rote learning practices such as cramming mathematical and scientific formulae. Mastery of the subject matter had to be emphasised for better understanding of the concepts.
- Natural science teachers needed to employ teaching strategies that could engage all students during physical science lessons. They needed to use learner-centred teaching methods that would make even introverted students open up, such as group discussions and rapport-building classroom interactions. Park (2016) suggests rapport-building strategies like engaging students in informal conversations, integrating humour into classroom interactions, softening corrections with compliments and demonstrating empathy toward students. The physical science students appreciated hands-on activities such as experiments. It is, therefore, recommended that natural science teachers intersperse their traditional lessons with enough experiments for all the science concepts they teach.

- It is also recommended that every assessment task prepared for students has to have a few high-order thinking problems. The hierarchy from simple recall problems to high-order thinking problems has to be maintained, lest less motivated students can lose interest in the subject and probably give up because of poor scores. Good scores made students want to do even better, while low scores made them lose interest in the subject. Constructive and private comments, accompanied by corrections softened with compliments (Park, 2016), boosted the morale of low performing students. Natural science teachers can thus be encouraged to give constructive criticism to their students to avoid creating a bad attitude in the students towards the subject or teacher. Creating a positive learning environment is described by Park (2016) as a critical role of a teacher. Only highly motivated students were observed to work even harder in case they scored low marks
- Students have to be taught about the dangers of ignoring concepts they do not understand. They need to be encouraged to seek further clarification instead of relying on others for answers or solutions. The practice of asking for explanations built confidence among students and made them work even harder.
- Teachers have to encourage students to talk and write more during natural science lessons. The use of learner-centred teaching strategies would do this for the teachers. Teachers also need to assist and support their science students in every way possible, individually and as a class, publicly and privately.

5.2.2 Findings with regard to the purpose of the study and the third research sub-question:

What is the effect of feedback during natural science learning?

During the pre-motivation phase of data collection most students failed to submit their work to their teachers for marking. They gave varied reasons for not submitting their work and their understanding of the science matter was poor. However, during the motivation phase of data collection submission of science work for marking was not a challenge. Instead of keeping their work to themselves, the students were more willing to submit it to the teacher for correction. The students were encouraged by the teachers' corrections and comments. Students even understood the importance of submitting their work on time; allowing teachers to discover their challenges and thus prepare other teaching strategies.

Poor performance in any piece of work disappointed students. During the pre-motivation phase poor performance led students to give up and accept failure. However, things changed during the motivation phase. Students developed interest in understanding science concepts and became self-regulated. They would even ask for more work from their teachers and appreciated the feedback. They were able to do their work with understanding instead of copying from other students. In case of difficulties, they approached their teachers or even their colleagues and habitually used the library and the internet.

Teachers were able to give feedback faster and students would then make corrections while their work was still fresh on their minds ensuring the concepts were mastered. After submitting assignments to their teachers students would be eager to know their performance and teachers were thus forced to return submitted work as early as possible. Positive feedback and constructive comments during lessons made students depend more on their science teachers than on their colleagues for academic help. Positive feedback also made students gain confidence in themselves.

Recommendations:

❖ Teachers need to motivate their science students to the point where students become self-regulated. Poor performance should motivate them to work harder for a better score rather than give up on the subject. To obtain information students need to be encouraged to make good use of all the available sources and resources.

- ❖ Science teachers need to give their students feedback promptly. Delayed feedback makes students lose interest in the concept and discourages them from making corrections. When feedback is quick students are enthusiastic to make corrections.
- ❖ Private and individual feedback boosts the self-esteem of a student. Science teachers may thus be encouraged to regularly call certain students aside especially those who seem to need special attention in certain topics.

5.2.3 Findings with regard to the purpose of the study and the fifth research sub-question:

Which strategies improve interactions during natural science learning?

The use of a simplified science textbook improves students' understanding of a subject. Simplified language and colourful illustrations encourage students to read more. The students suggested a separate textbook for each component of physical science in place of their present textbook which had both chemistry and physics in one book and was both heavy to carry regularly and complicated.

Giving students time to think out responses to oral questions during lessons also helped students understand science concepts better. Thinking demands time and energy, especially if a high-order question has been asked. The rate at which information is processed in the brain will vary from person to person, depending also on urgency and magnitude of the matter, as well as alertness of the brain. Teachers must allow their students time (say up to three minutes) to process answers. Even 'mental questions' in mathematics need thinking time, though it must be very short.

Allowing students time during lessons to prepare for an assessment activity improved interactions during natural science lessons. During such time students interact informally and freely. They can even use slang in addition to classroom and everyday talk. They may even move from place to place within the classroom in search for information among their classmates. The chemistry group enjoyed being allowed time by their teacher and utilised it. It improved morale among the students. Giving the students time during lessons to write homework, classwork and quizzes motivated them to put more effort into their work, assist each other and thus understood the concepts better. Students also appreciated being allowed to ask questions during lessons. That was also the right time for them to debate certain concepts with their science teachers.

Giving students constructive feedback also encouraged them to do more school work and to submit their work on time. During the motivation phase of data collection, students enjoyed the learning process to such an extent that their teachers were just there to facilitate the process. Teachers were not struggling to make their students understand concepts. Instead, the students were so motivated that they were the ones seeking understanding instead of being forced as was the case during the pre-motivation phase (ZPD).

Experiments also motivated students to talk more during natural-science lessons. They would talk with peers and their science teachers for the sake of understanding the lessons. They would talk about the procedure for conducting the experiment, the results, or how to report on the experiment. When teachers gave their students individual attention (in case they did not understand certain concepts) the students were encouraged to contribute more constructively during science lessons. The students developed self-efficacy and they experienced a boost in self-esteem. This confidence allowed them to contribute openly to discussions during lessons.

After posing difficult questions, it was advantageous for teachers to point at the best students in class, calling on them to answer the questions. The intention was to avoid exposing the hesitant students' lack of knowledge in the subject matter. At times, rephrasing questions helped students to understand the questions better, and thus they were better-informed to answer those questions. Varying teaching strategies also improved student discourse during lessons.

Teaching about current and controversial issues improved discourse during natural-science classes. Students debated a lot in class once a controversial concept was raised.

Even shy students contributed, though they did so indirectly in most cases. Through formal classroom debates, controversial issues were an effective teaching tool. Dividing students into teams and making the teams compete engaged every learner to take part in the debate in one way or another. When open debates and arguments were used, students in science classes came alive with effective talk and discussion; this was especially true during the motivation phase of data collection.

The motivation method gave students the energy to talk during science lessons, as alluded by one of the teachers. Students also enjoyed being taught science in the laboratories. Experiments and models excited them and encouraged more discussion during science lessons. Finally, the students appreciated hands-on activities.

Recommendations

- The use of simplified, both orally and in writing, language is recommended when teaching natural-science students so that they can understand science concepts. Even complex scientific phenomena, when explained in simple language, become comprehensible to the average student. It is therefore recommended that textbooks assigned to science students be written in plain language—even more important because English is a second language to Swazi students. It is also recommended that the illustrations (figures, tables, diagrams, pictures, etc.) be colourful as colour appeals more to young people. Note that using simple language does not mean the use of everyday language all the time but that there should be a balance between everyday language and classroom language; with both languages using simple and concise terms, usually in descriptions and explanations.
- It is also recommended that textbooks assigned to science students be of reasonable size since students are less likely to carry around larger textbooks. We are now living in a technological world where information is

stored in microchips and the cloud. A good solution would be for schools to go digital, especially in rural communities.

- ❖ Science teachers are also urged to give their students time, for example, up to three minutes, to formulate responses to oral questions. Students may also be given time to prepare for tests and examinations during class time. This gives students time to assist each other (thus narrowing the ZPD).
- ❖ Science teachers should give their students plenty of practice activities such as past exam booklets to prepare them for tests and examinations. Prompt and constructive feedback also encourages students to interact more during science lessons. Individual attention should be given to students (where possible).
- ❖ Organising debates on certain topics or concepts also engages students more during written and oral discourse. Debates develop social skills such as tolerance and listening in students. Science teachers should regularly conduct debates with their students for improved classroom outcomes.
- ❖ Science teachers are also encouraged to use teaching aids in the science laboratory. Students enjoy learning science in the laboratory. They are also fascinated by the application of technology in teaching.

5.3 Recommendations for future research

Recommendations for future research revolve around the research methodology. In future, it is recommended that this study be done quantitatively, with a questionnaire implemented for data collection. The respondents would give a somewhat truer perspective of how they feel about the motivation method, since they would answer the questionnaire in their own comfort zones, privately. Again, without an interviewer in front of them, they would be freer to express their feelings about their understanding of science concepts during the motivation phase compared to the pre-motivation phase. The advantages of a quantitative study would be to:

- involve a wider and bigger population sample,

- enable generalisability,
- involve statistical methods of data analysis (SPSS).

5.4 Contribution of the study to scholarship

This study on enhancing discourse in a natural-science classroom in high school contributes to the body of knowledge about teaching science in high school to Swazi students and elsewhere. It is one of the studies future researchers can reference when researching about teaching natural sciences in a rural high school. The study found that extrinsic motivation can trigger intrinsic motivation in physical science students to own and value learning. The motivated students self-regulated their learning and gained confidence. Self-regulated students interacted better with their teachers, with each other, and with resources for better achievement in the natural sciences. The study has suggested a practical method for motivating students to learn actively, especially within the context of a science classroom. The motivation method also helps to create an atmosphere conducive to learning as it improves the behaviour of students such that their teacher does not struggle, and waste time with classroom management practices.

Classroom management is one aspect previous studies did not address directly during the motivation of students to learn natural sciences. So, this study fills up that gap in literature. The motivational points too were an unusual form of external motivation. The science teachers did not have to spend money to get tokens for motivating the students; but marks.

5.5 Concluding remarks

This chapter began by presenting an overview of the previous chapter making up this study, followed by the major findings of the study, which responded to the main question and sub-questions presented in chapter one section 1.3. Three major findings and their recommendations are presented in this chapter. The first major findings considered were with regard to the main research question and the purpose of the study. The motivation method used with the students improved discourse within the natural science classroom, resulting in a better understanding of scientific concepts. The motivation method instilled self-discipline among the students, and this resulted in self-regulated behaviour and a positive teaching/learning atmosphere for everyone in the classroom. Because of the positive teaching/learning atmosphere, syllabus coverage improved, as well.

The second major findings were with regard to the purpose of the study and the third research sub-question, which was:

What is the effect of feedback during natural-science learning?

During the pre-motivation phase of data collection, some of the students did not see the importance of submitting their work for marking by their science teachers. However, this changed during the motivation phase. Students enjoyed doing and submitting their work on time. That improved their appreciation and understanding of science concepts. It also allowed them to contribute more during science lessons. Thus, instructor feedback encouraged students to make corrections to their own work and to ask for more science work. They even sought information from varied sources and stopped copying answers from each other just for the sake of submitting. They were most encouraged by quick feedback from their teachers, and they no longer feared approaching their science teachers for information. Their self-esteem was thus boosted.

The third major findings were with regard to the purpose of the study and the fifth research sub-question, which was:

Which teaching strategies improve interactions during natural-science learning?

The use of plain language within the science classroom improved interactions during natural-science learning. Teachers should assign books that are written in as simple a scientific language as possible in order for learners to comprehend the contents. Even the language that teachers speak during teaching should not be far above or below the students'. Science teachers should also give students time to think after asking them oral questions. Some students appreciate being given time during school hours to prepare for tests and examinations, and at times to write other assignments, since in their homes they may not get such time because of home chores and other reasons. Teachers may also organise formal debates for their students on certain controversial issues.

Experiments and teaching aids, such as models, charts and videos, motivated students and increased their interest in science. Individual attention also motivated students to strive to understand and improve. Rephrasing or repeating questions asked also helped students interact more during natural-science lessons. Lastly, students enjoyed taking science lessons in science laboratories and doing hands-on tasks.

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APPENDICES

APPENDIX A: *Permission letter to the Regional Education Officer*

Request for permission to conduct research at Ntfonjeni National High School

Title: **Enhancing discourse through motivation: A case study of high school teaching in Swaziland.**

The Regional Education Officer - Hhohho
P.O.Box 92
Mbabane
H100
Swaziland [Tel: (+268) 2404 3761]

Dear Sir/Madam

I, Vusi F Sitsebe, am doing research with my supervisor Prof Abraham Motlhabane, an associate professor in the Department of Science and Technology, towards a D Ed at the University of South Africa. We are inviting Ntfonjeni National High School to participate in a study entitled **Enhancing discourse through motivation: A case study of high school teaching in Swaziland.**

The main aim of the study is to suggest an instrument to be used by teachers to encourage student discourse during learning. This is a motivation instrument that also enhances feedback between students and their teachers, as well as achievement among students. This school has been selected purposefully to participate in this study since it can provide valuable experience and expertise on my topic.

The study will entail natural science lesson observations and semi-structured interviews both of which will run in two stages: pre-motivational stage and motivational stage. Six Form 5 students selected with the help of their natural science teacher, together with their teacher, will be interviewed before and after each stage. Each interview will be audio-recorded and will last about 30 minutes. Documents such as classwork books, test and examination scripts will be requested from students as part of data collection.

The study will benefit Ntfonjeni High School students and students from other schools by motivating them to engage actively in discourse during natural science lessons. Active student involvement during lessons informs teachers about students' levels of understanding a certain concept, thus teachers can adopt better teaching strategies for student understanding. This instrument, if implemented successfully, can be adopted by teachers of other subjects as well.

Please note that your name, the name of the school and the names of the participants will be withheld in the reporting of the data. No information shared will be disclosed to members of staff at the University in a way that will allow them to identify the source. I shall follow research ethics regulations of the University of South Africa and use collected information for purposes of this study only. Confidentiality and anonymity are guaranteed and as such there are no potential risks to the participants foreseen.

Shortly after the transcription of the audio-recorded interviews the participants shall be given a copy so that they may confirm the accuracy of our conversations or clarify any points. Also, when I am finished with my study I shall give a short talk to the school about some of the helpful and interesting things found in my study. The participants shall be invited to come and listen to my talk.

Yours sincerely

VF Sitsebe (Researcher).

CC The Grantee – National Schools
The Principal – Ntfonjeni National High School

APPENDIX B: ***Letter requesting a teacher to participate in interviews***

A LETTER REQUESTING A TEACHER TO PARTICIPATE IN INTERVIEWS

Dear Mr. AN Dlamini

This letter is an invitation to consider participating in a study I, Vusi F Sitsebe, am conducting as part of my research as a doctoral student entitled **Enhancing discourse through motivation: A case study of high school teaching in Swaziland** at the University of South Africa. Permission for the study has been given by the Principal and the Ethics Committee of the College of Education, UNISA. I have purposefully identified you as a possible participant because of your valuable experience and expertise related to my research topic.

I would like to provide you with more information about this project and what your involvement would entail if you should agree to take part. The importance of student discourse in education is substantial and well documented. Teachers need to adopt teaching methods that encourage students to engage actively in science lessons for better achievement. The research is divided into two phases: the pre-motivational and the motivational. Each phase begins and ends in a lesson observation and an interview. In these interviews I would like to have your views and opinions on this topic. This information can be used to improve student interactions with each other, their teachers and with the subject matter.

Your participation in this study is voluntary. It will involve lesson observations and interviews of approximately 30 minutes each, to take place in a mutually agreed upon location at a time convenient to you. You may decline to answer any of the interview questions if you so wish. Furthermore, you may decide to withdraw from this study at any time without any negative consequences.

With your kind permission, the interviews shall be audio-recorded to facilitate collection of accurate information and later transcribed for analysis. Shortly after the transcription has been completed, I shall send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversations and to add or to clarify any points. All information you provide is considered completely confidential. Your name will not appear in any publication resulting from this study and any identifying information will be omitted from the report. However, with your permission, anonymous quotations may be used. Data collected during this study will be retained on a password protected computer for 5 years in my locked office. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at (+268) 2431 3499 or by e-mail at vsitsebe@gmail.com.

I look forward to speaking with you and thank you very much in advance for your assistance in this project. If you accept my invitation to participate, I will request you to sign the consent form which follows on next page.

Yours sincerely

Vusi F Sitsebe

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CONSENT FORM

I have read the information presented in the information letter about the study **Enhancing discourse through motivation: A case study of high school teaching in Swaziland** in education. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and add any additional details I wanted. I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses. I am also aware that excerpts from the interview may be included in publications to come from this research, with the understanding that the quotations will be anonymous. I was informed that I may withdraw my consent at any time without penalty by advising the researcher. With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

Participant's Name (Please print):

Participant's Signature:

Researcher's Name (Please print):

Researcher's Signature:

Date:

APPENDIX C: ***Letter requesting an adult student to participate in interviews***

A LETTER REQUESTING AN ADULT STUDENT TO PARTICIPATE IN INTERVIEWS

Dear Musa Dlamini

This letter is an invitation to consider participating in a study I, Vusi F Sitsebe, am conducting as part of my research as a doctoral student entitled **Enhancing discourse through motivation: A case study of high school teaching in Swaziland** at the University of South Africa. Permission for the study has been given by the Principal and the Ethics Committee of the College of Education, UNISA. Your science teacher has purposefully identified you as a possible participant in this research.

I would like to provide you with more information about this project and what your involvement would entail if you should agree to take part. The importance of student discourse in education is substantial and well documented. Teachers need to adopt teaching methods that encourage students to engage actively in science lessons for better achievement. The research is divided into two phases: the pre-motivational and the motivational. Each phase begins and ends in a lesson observation and an interview. In these interviews I would like to have your views and opinions on this topic. This information can be used to improve student interactions with each other, their teachers and with the subject matter.

Your participation in this study is voluntary. It will involve lesson observations and interviews of approximately 30 minutes each, to take place in a mutually agreed upon location at a time convenient to you. You may decline to answer any of the interview questions if you so wish. Furthermore, you may decide to withdraw from this study at any time without any negative

consequences. With your kind permission, the interviews shall be audio-recorded to facilitate collection of accurate information and later transcribed for analysis. Shortly after the transcription has been completed, I shall send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversations and to add or to clarify any points. All information you provide is considered completely confidential. Your name will not appear in any publication resulting from this study and any identifying information will be omitted from the report. However, with your permission, anonymous quotations may be used. Data collected during this study will be retained on a password protected computer for 5 years in my locked office. There are no known or anticipated risks to you as a participant in this study.
If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at (+268) 2431 3499 or by e-mail at vsitsebe@gmail.com.

I look forward to speaking with you and thank you very much in advance for your assistance in this project. If you accept my invitation to participate, I will request you to sign the consent form which follows on the next page.

Yours sincerely

Vusi F Sitsebe

****

CONSENT FORM

I have read the information presented in the information letter about the study **Enhancing discourse through motivation: A case study of high school teaching in Swaziland** in education. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and to add any details I wanted. I am aware that I have the option of allowing my interviews to be audio recorded to ensure an accurate recording of my responses. I am also aware that excerpts from the interviews may be included in publications to come from this research, with the understanding that the quotations will be anonymous. I was informed that I may withdraw my consent at any time without penalty by advising the researcher. With full knowledge of all the foregoing, I agree, out of my own free will, to participate in this study.

Participant's Name (Please print):
Participant's Signature:

Researcher’s Name (Please print):

Researcher’s Signature:

Date:

APPENDIX D: *Interview schedule*

STUDENT DISCOURSE MOTIVATION METHOD: INTERVIEW QUESTIONS

Phase 1: Pre-motivation Stage

1. **Questions for the Teacher**

    a) Are your students motivated to learn chemistry?
    b) Do you motivate them to talk in class? What strategies do you employ?
    c) How is their performance in chemistry?
    d) When given some chemistry work to do at home do they observe submission deadlines?
    e) How quick do you give them feedback on submitted chemistry work? What effect does the feedback have on student motivation?
    f) In your view what strategies can improve student performance in chemistry?

2. **Questions for the Students**

    a) In your view is chemistry an interesting subject?
    b) Are you happy about the way chemistry is taught?
    c) How frequent do you talk during chemistry lessons? Never/rarely/often/always.
    d) When do you talk during chemistry lessons? Is it when you are asking questions; answering the teacher’s questions or only when probed by the teacher?
    e) Is talking in class helpful? Yes or no? Give reasons.
    f) When given some assignment to do at home do you submit that work on time? Why/ why not?
    g) How can your performance in chemistry be improved?

Phase 2: Motivation Stage

1. **Questions for the Teacher**

    a) Are your students now motivated to learn chemistry? Why?
    b) Do they ask for more work than you give them?
    c) In your view has student performance improved compared to phase 1?
    d) How often do your students now talk during chemistry lessons?
    e) How has the motivational method used with the students contributed to their talk and performance?
    f) Would you recommend this motivational method to other teachers?

2. **Questions for the Students**

    a) In your opinion is chemistry interesting?
    b) Are you happy about the way chemistry is taught?
    c) How is your performance in chemistry?
    d) How can your performance be improved?
    e) Do you talk during chemistry lessons? Is that helpful?
    f) How good are you at doing and submitting assignments?
    g) Should this motivational method used with you be adopted by other teachers? Why?

APPENDIX E: *Classroom observation protocol*

Classroom Observation Protocol

PRE OBSERVATION DATA

Teacher ___________________ Date __________________
School ___________________ Grade/Level _____________
Observer __________________ Programme ______________

(***Fill this out prior to observing classes.***)

Class period or time of class:
Topic or topics:
Placement of class or lesson within the unit of study:
Purpose (objectives):

Materials Used (teacher-made, manufactured, district or department-developed; characterisation of materials):

How students will be assessed (for this lesson):

CLASSROOM ACTIVITIES

Teacher: Date:

(***Fill this out as you are observing classes.***)
Introduction to Lesson: provides introduction/motivation/”invitation”; explains activity and how it relates to previous lessons; assesses students’ prior knowledge

Student Grouping ___________ Duration _______________

First Activity/Task: Content; nature of activity, what students doing, what teacher doing; interactions.

Student Grouping ___________ Duration _______________

Second Activity/Task: Content; nature of activity, what students doing, what teacher doing; interactions.

Student Grouping ___________ Duration _______________

Third Activity/Task: Content; nature of activity, what students doing, what teacher doing; interactions.

Student Grouping ___________ Duration _______________

State whether activities are sequential or are different activities/tasks done at the same time:

STUDENT DATA

Teacher: Date:

(***Fill this out during/after the classroom observation.***)

1 - Number and gender of students:

2 - Describe the content of a student's notebook:

Use pages 3-4 of *Instructions for Filling out the Classroom Observation Protocol* for operational definitions of student behaviours.

Student Behaviours:

most students off task -- most students on task

students interact with each other around non-academic or procedural issues -- students interact with each other around content issues

students are hesitant to enter into the discussion/activity -- students actively and enthusiastically participate in the discussion/activity

TYPOLOGY: INQUIRY-BASED TEACHING AND LEARNING

Teacher: Date:

(***Fill out after the classroom observation.***)

Use pages 4-8 of *Instructions for Filling out the Classroom Observation Protocol* for operational definitions for typology.

<u>Students</u>:

look for correct answer -- accept or revise their "hypotheses" based on evidence

do not reflect on others' ideas -- reflect on others' comments/ideas

seek information to complete the assigned work -- seek clarification of conceptual understanding

<u>Teacher Role</u>:

source of knowledge -- facilitator

questions/comments seek memory/ facts -- questions/comments seek comprehension/ opinion

<u>Classroom Activities</u>:

algorithms -- heuristics

<u>Emphasis</u>:

abstract --- world

Materials:

prescribed programme --- compiled by teacher

TYPOLOGY: INQUIRY-BASED TEACHING AND LEARNING

Teacher: Date:

For Discussions

Amount of Time Observed:

Percent of students contributing to the discussion:

closed questions -- open-ended questions

teacher seeks facts -- teacher seeks student understanding

students do not use evidence to support claims -- students use evidence to support claims

teacher talks -- students talk

students talk only to teacher -- students talk to one another

teacher provides reasoning -- teacher helps students reason through thinking process

For Laboratory/Hands-On/Fieldwork

Amount of Time Observed: Part of a project (yes, no):

Grouping (pairs, threes, fours):

Cooperative/collaborative (yes, no):

students follow a procedure to answer a question or conduct an investigation -- students answer a question or solve a problem using open ended instructions

students take measurements or determine facts to answer questions (one answer) -- students collect and manipulate data in order to answer questions (several answers possible)

REFLECTIONS AND INTERPRETATIONS

Teacher: Date:

(***Fill this out as soon as possible after the classroom visit.***)

1 - Overall, what happened during the classroom observation (e.g., which teaching strategy was the teacher using and how effective was its implementation)?

2 - What didn't happen (e.g., students didn't grasp the idea of the lesson)?

3 - Alternative ways teacher might have handled the lesson/question/ situation:

4 - Characterise students and their attitudes toward the subject matter and the teacher:

5 - Notable non-verbal behaviour:

6 - Surprises/concerns, especially related to the programme goals (e.g., the teacher didn’t appear to be using the learner-centred teaching approach):

INSTRUCTIONS FOR FILLING OUT THE CLASSROOM OBSERVATION PROTOCOL

Try to schedule your visit to coincide with the main purpose for your visit. For example, to ascertain the extent to which inquiry is part of the learning process, observing during a discussion of a previously conducted experiment or hands-on exercise provides the best data.

During your visit collect any worksheets, lab sheets, other hand-outs or work associated with the lesson.

PRE-OBSERVATION DATA

If possible, try to fill this out prior to observing classes.

Time of class and duration:
Note the time and duration of class period(s) you will be observing. Ask the teacher how often s/he teaches science and to what extent science is a regular part of the day or week.

Topic:
Ask the teacher to tell you the name of the topic that will be addressed in the class you will be observing.

Placement of class or lesson within the unit of study:
Note whether the topic taught is somewhat in the beginning, middle, or end of the unit of study.

Purpose (objectives):
Ask the teacher to list the objectives for the class you will be observing.

Materials Used (teacher-made, manufactured, district or department-developed?):
Ask the teacher to describe what materials he or she will be using to teach the topic. These materials may include anything from textbooks, overheads, worksheets or a computer

programme. Be sure to try to get a copy of any materials used such as student worksheets or reports. The materials can be characterized in a variety of ways. Record here the extent to which the materials may support the programme goals (e.g., Do the materials promote development of thinking skills?)

How students will be assessed (for this lesson):
Ask the teacher what methods are planned, and try to get a copy of any assessment tools/instruments.

CLASSROOM ACTIVITIES

As you are observing the class, take notes on what you observe in the appropriate boxes. If you like to write extensive notes write on the back of the Classroom Activities sheet.

Introduction to Lesson:

Describe how the teacher starts the lesson (e.g., gives a content overview, relates the content to previous work or to science). While it is assumed the student grouping will be whole class, there may be an occasion where it is not. Fill in the amount of time (Duration) the teacher introduces the lesson.

Activity/Task:

Describe the content and the nature of the lesson or classroom activities including the method of teaching, how/if students are grouped/interacting. Describe what the students are doing e.g., listening and taking notes, writing answers to questions. Describe how the teacher is interacting with the students, and how the students are interacting with one another.

If several activities are occurring at the same time indicate so at the bottom of the page. If more room is needed for notes, write on the back of the sheet.

OTHER OBSERVATIONAL DATA

Fill this out during the classroom observation.

1 - **Description of the classroom:**

Describe how the seating is arranged, number and kind of windows and lights, describe/list any special equipment or materials. Note especially if there are separate areas for different activities (e.g., a "library" with a place for students to sit). Describe what is on the walls, especially bulletin board displays. Give an overall general description of the size of the room, e.g., 'large' is sufficient.

2 - **Teaching aids/materials (per activity/task if appropriate):**

All materials including chalkboard, overhead projector, teacher-made handouts, textbook, should be listed.

3 - **Assessment strategies used (per activity/task if appropriate):** If during the observation the teacher uses some form of assessment strategies, record them. For example, a teacher may circulate among students doing work in small groups and make notations on a check-sheet.

4 - **Time not devoted to teaching and nature of non-academic or procedural activity (e.g., management, announcements, discipline); description of non-instructional event:**

Give approximate percent of time or actual time not directly devoted to instruction (teacher instruction, self-instruction, student-to-student instruction). Non-instructional time may be a variety of things including stopping to discipline students, talking about last nights' ballgame, or listening to announcements over the intercom.

STUDENT DATA

Complete items 1 and 2 when appropriate, e.g., you may get the data on number of minorities from the teacher after the observation, or, you may make that assessment yourself during your observation.

1 - **Number and gender of students; number of minorities/majority:**

Record the total number of students present during most of the class (it is expected that occasionally a student will enter or leave during the class period). Record the number of females and males. Under certain circumstances figuring minorities is not always easy, partly because of students with varied racial and ethnic backgrounds. An estimation is acceptable. You may want to get this information from the teacher prior to the classroom observation.

2 - **Describe the content of a student's journal or notebook for the class.**

Find out from the teacher if the students are expected to keep a journal or notebook. Ask each of the participant students if you can look at their notebook. Record the kinds of entries, the number of pages, and especially note if there is any evidence of problem solving, data collection and analysis, self-evaluation or other type of critical thinking.

OPERATIONAL DEFINITIONS FOR STUDENT BEHAVIOURS

The continua include undesirable student behaviours on the left and desirable student behaviours on the right. For each indicate the degree or percentage of desirable and undesirable behaviour.

• most students off task = 50% or more of the students are not on task for at least 50% of the class period.

- most students on task = 90 - 100% of students are on task for the entire class period (100% of the time).

• students interact with each other around procedural issues = they are asking one another such things as, "What did he say?" or, "Do we answer questions 5 and 6 or just 6?"

- students interact with each other around content issues = students are actively interacting around the lesson or topic. In some cases students may seem off topic because they are talking about a related issue. Even if the issue is not directly related it should be considered as interacting around content issues.

• students are hesitant to enter into the discussion/activity = students do not actively engage in discussion or engage in an activity and are likely only to answer direct questions posed by the teacher. You may see body language that corroborates their reluctance.

- students actively and enthusiastically participate in the discussion/activity = during a discussion, students are probably calling out answers and/or engaging one another in some point of discussion such as arguing with one another around an issue. During an activity, students are actively engaged.

OPERATIONAL DEFINITIONS FOR TYPOLOGY

The typology is meant to capture, in retrospect, the observer's overall interpretation of where the teacher's practice may fall on each of the continua. The items in the left column are generally more 'traditional' and the items in the right column generally reflect more inquiry. No value judgment of the teacher is intended. Value judgments should be left to REFLECTIONS AND INTERPRETATIONS. Each item is intended to refer to something that might be transferred from the teacher's participation in the programme to their classroom practice. Place an 'x' on the spot you feel best indicates what you observe for that class/lesson. You might think of the line in terms of percent, e.g., if the teacher acts like a source of knowledge for 40% of the time and is a facilitator 60% of the time put the 'x' to the right of the half-way point toward 'facilitator'.

Write any explanatory notes in the margin or indicate "N/A" if the continuum is not applicable to the class you observed. For example, the continuum in the Discussion section, "teacher helps students reason through the thinking process --- teacher provides reasoning" is not applicable in cases where there is no attempt to bring students' understanding or thinking about a subject/idea to a higher level. In this case record both 'N/A' and a brief comment about the nature of the discussion.

Students:

• look for correct answer = students do an activity or engage in discussions and focus on "getting the correct answer" (as opposed to "seek truth").

- accept or revise their "hypotheses" based on evidence = students have developed some ideas prior to the current lesson, perhaps through a classroom activity. This was their prior idea; it may even have been a hypothesis they developed. Now, they use new evidence, either direct or through a discussion, and revise their idea based on that evidence.

• do not reflect on others' ideas = students do not build on what other students say nor refer to what other students might be saying; neither do they act on other students' ideas and/or suggestions.

- reflect on others' comments/ideas = students relate to what others say through discussion or taking some action. Students build on what other students say but may not directly acknowledge them by name.

• seek information to complete the assigned work = students may ask questions about procedure such as asking the teacher or other students if they should finish the exercise for homework, or, may ask direct questions about how to answer a particular question in order to complete an assigned task.

- seek clarification of conceptual understanding = students ask the teacher or other students for explanations and clarifications of the questions asked in order to better understand the content. During a discussion a student may relate an experience s/he has had related to the topic in order to fit this information into his or her conceptual understanding of the topic.

Teacher Role:

• source of knowledge = teacher is the "sage on the stage" and neither seeks nor acknowledges student input. The teacher may ask students questions but only in order for them to relate facts or content-specific information.

- facilitator = teacher seeks input from students and encourages students to explain, predict, describe, etc. in order to increase their and other students' understanding. The teacher will often seek a student's misunderstandings and ask other students to offer a better/different explanation, prediction, etc. versus "correcting" a student. In laboratory or hands-on activities, the teacher will offer suggestions and/or work with the students to find solutions or work out problems.

• questions/comments ask for memory/fact = teacher looks for the correct answer around a fact such as asking for a definition. The teacher generally asks short answer questions that require memory.

- questions ask for comprehension/opinion = teacher asks probing questions and/or encourages discussion which requires student understanding. (Understanding = the student can apply what they know to a new situation by explaining, giving examples, predicting and interpreting.) The teacher generally asks questions that require processing, however, the processing may not be in the form of a direct question. Look for implicit and as well as explicit questioning.

Classroom Activities:

• algorithms = procedural steps or formula to solve problems and/or answer questions. This is most often seen in mathematics classes where students are taught to use a specific procedure to solve mathematics problems. In a science class it is often seen in 'cookbook' laboratory manuals.

- heuristics = use of overall strategies or plan to solve problems and/or answer questions. This can be seen wherever students are asked to use critical thinking skills. (Critical thinking skills include problem solving, evaluation, decision-making, deductive and inductive reasoning.)

• abstract = the content may be of academic interest but is not directly related to a student's everyday experience. Students usually perceive the content as something they must learn in school, and may have to know to pass a test, but isn't anything they would have to deal with in their 'real-life.' (Note: it is students' perceptions that count, therefore, to make this entry, you have to talk with students or base your judgment on something said in class.)

- connected to real-world = the content is perceived as relevant to something in the students' lives or to the understanding of something in the real-world. It may also be related to something that exists in the real-world, such as something the teacher experienced in the laboratory, but is not directly part of the students' experiences.

• prescribed programme = students/teacher use(s) the assigned textbook or some part of a commercially prepared textbook package such as worksheets. If the prescribed programme promotes compiling materials, place an 'x' in the position that best describes the proportion of prescribed versus compiled. Note that the Pre Observation Data sheet has a place for characterising the materials.

- compiled = students/teacher use several different kinds of materials such as another textbook, books, magazines, audio-visual, computer materials compiled by the teacher.

Discussions: note whether or not this is more like ‘recitation’ than ‘discussion.’

• closed questions = no matter who talks with whom, the discussing group seeks to determine the right answer, which is usually a fact. (Note: the “questions” may be implicit. This continuum is meant to capture the overall tenor of the discussion as being closed or open.) A typical closed question is, “What is 4 x 4?”, or “What are the temperature and moisture conditions that define a desert?”

- open-ended questions = no matter who talks with whom, members of the discussing group are seeking possible explanations/causes/descriptions/understandings. A typical open-ended question is, “What do you think might happen if...?”, or “If you got a ‘4’ for the answer and I got a ‘6’, why might our answers be different?”

• teacher seeks facts = the teacher encourages students to determine ‘the’ answer to a question or ‘the’ solution to a problem.

- teacher seeks student understanding = the teacher seeks students’ understandings and misunderstandings, often as a way to determine class and individual progress (perhaps as a form of assessment).

• students do not use evidence to support claims = students give factual answers or read facts off a workbook or laboratory page without further explanation.

- students use evidence to support claims = students provide data or collaborating evidence to support what they are saying. For example they might say, “I saw that the longer the water was heated the higher the temperature got which explains that ...”

• teacher talks = amount of time teacher talks during the discussion.

- students talk = amount of time students talk during the discussion. (Note also the number of students who are doing the talking.)

• students talk only to teacher = the ‘discussion’ may be characterised as more of a recitation when the interaction is between teacher and students, however, the continuum suggests that there is probably some mixture among students talking with the teacher and talking to one another.

- students address one another = students turn toward and talk with one another without the teacher as a mediator. (Note: this is to be taken literally. Students may refer to what one another has said without talking directly to that student. This kind of interaction is captured in another continuum.)

• teacher provides reasoning = teacher may help students understand a topic/principle/idea through providing them with the reasoning behind.

- teacher helps students reason through thinking process = teacher asks for students' reasoning, encouraging them to support and contradict one another through discussion. At both ends of this continuum, student understanding may reach a higher level, but this end of the continuum is intended to capture the constructivist approach whereby students are helped in their understandings starting from their own perspectives/observations.

<u>For laboratory/Hands-on/Fieldwork</u>

• students follow a procedure to answer a question or conduct an investigation = this refers to what educators often call "cookbook" investigations.

- students answer a question or solve a problem using open-ended instructions = this refers to anything that is more inquiry-oriented.

• students take measurements or determine facts to answer questions (one answer) = the results of the investigation are a series of one right answer even though the students may be taking measurements and even collecting other data.

- students collect and manipulate data in order to answer questions (several possible answers) = there is no one answer but several answers that are appropriate because students are collecting and manipulating data related to a phenomenon.

1 Table.1.1 shows some properties of substances A, B, C and D

Table 1.1

substance	state	soluble in water	miscible with water
A	solid	yes	–
B	solid	no	–
C	liquid	–	yes
D	liquid	–	no

State the method of separation for the following mixtures:

(a) a mixture of a solution of A and solid B

filtration .... [1]

(b) a mixture of C and D

fractional distillation .... [1]

2 **Fig. 2.1** shows part of the Periodic Table

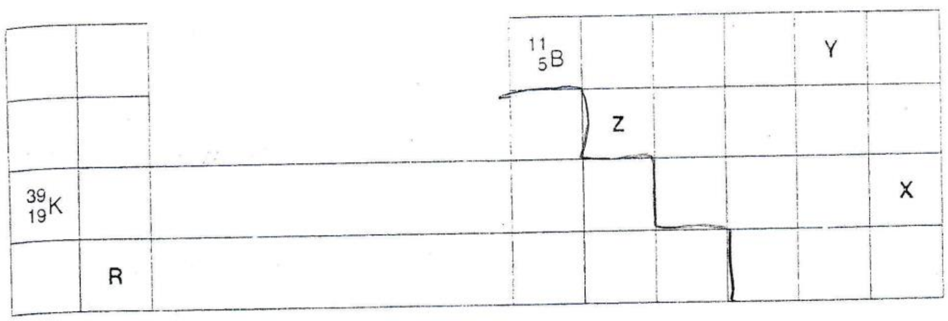

Fig. 2.1

The letters in bold are **not** the chemical symbols of the elements.

(a) Which letter R, X, Y or Z represents a metallic element?

Z .... [1]

(b) Explain why element X is not reactive.

It is because is in group 0 which are not reactive group.
has 8 electron in outer shell / full outer shell

(c) Which letter represents a halogen?

It does not have free electrons .... [1]

1 Table.1.1 shows some properties of substances A, B, C and D

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A	solid	yes	–
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C	liquid	–	yes
D	liquid	–	no

State the method of separation for the following mixtures;

(a) a mixture of a solution of A and solid B

Filtration 1 ....[1]

(b) a mixture of C and D

Fractional distillation 1 separation funnel ....[1]

2 **Fig. 2.1** shows part of the Periodic Table

			$^{11}_{5}B$				Y	
				Z				
$^{39}_{19}K$								X
	R							

Fig. 2.1

The letters in bold are **not** the chemical symbols of the elements.

(a) Which letter **R**, **X**, **Y** or **Z** represents a metallic element?

R 1 ....[1]

(b) Explain why element **X** is not reactive.

It is a noble gas ½ 8 electrons in outer shell ....[1]
or full outer shell.

(c) Which letter represents a halogen?

Y 1 .... $3\frac{1}{2}$ [1]

6 **Fig. 6.1** shows the structure of diamond, an allotrope of carbon.

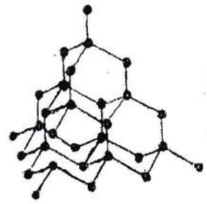

Fig. 6.1

(a) Explain, with reference to carbon, what is meant by the term *allotropy*

Allotropy is atom with different number of element. [2]

(b) Name the type of bond in diamond

Convelent bonding [1]

1

(c) Explain, using **Fig. 6.1** why diamond does not conduct electricity.

Diamond is made up of carbondioxide which have the atom that don't allow any charge

[2]

7. Magnesium metal reacts with hydrochloric acid to form magnesium chloride, and hydrogen gas.

Write a balanced equation to represent this reaction.

Mg + ch -> Mg ~~mes~~ + cH + h

2Mg + chl -> 2Mg ckl + H [2]

2Mg + ch -> 2mgchl + H

1

6 **Fig. 6.1** shows the structure of diamond, an allotrope of carbon

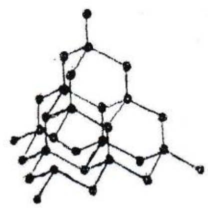

Fig. 6.1

(a) Explain, with reference to carbon, what is meant by the term ~~allotropy~~

elements that exist in two or more different

forms .... [2]

(b) Name the type of bond in diamond

~~covalent bonding~~ covalent bonding .... [1]

(c) Explain, using **Fig. 6.1** why diamond does not conduct electricity.

it is because each carbon atom is bonded to

4 other carbon atoms, meaning there is no any free

electrons .... [2]

7 Magnesium metal reacts with hydrochloric acid to form magnesium chloride, and hydrogen gas.

$Mg + HCl \rightarrow MgCl + H_2$

Write a balanced equation to represent this reaction.

$Mg + 2HCl \rightarrow MgCl_2 + H_2$ .... [2]

2

6

3 The Athletics Association uses chromatography to test for the presence of caffeine and paracetamol in urine samples from athletes.

Fig. 3.1 shows a chromatogram of caffeine (1) and paracetamol (2) alongside urine samples from four different athletes, A, B, C and D.

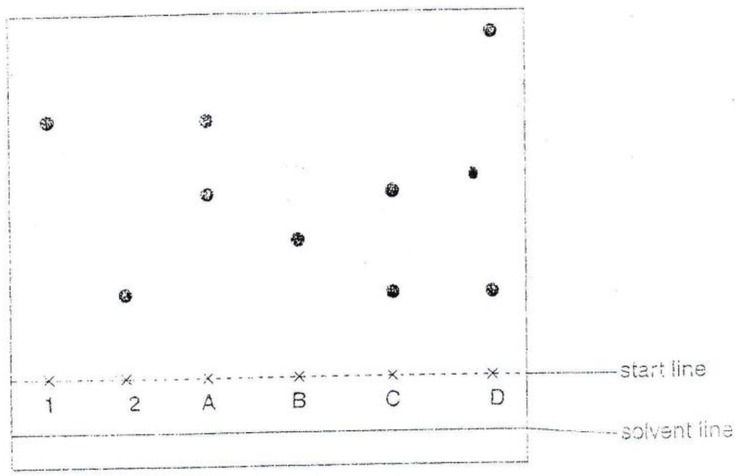

Fig .3.1

(a) Explain why the start line must be above the solvent.

It shows that does not dissolve in the solvent [1]

(b) Suggest conclusions that the Athletics Association could make about the presence or absence of caffeine or paracetamol in athletes A, B, C and D.

A More caffeine but less than D

B It have less caffine

C It have moderate caffine $\frac{1}{2}$

D It have more caffeine [2]

$\frac{1}{2}$

The Government of the Kingdom of Swaziland

Ministry of Education & Training

Tel: (+268) 2 4042491/5
Fax: (+268) 2 404 3880

P. O. Box 39
Mbabane, SWAZILAND

23rd May, 2016

Attention:
Head Teacher:
Nfonjeni High School

THROUGH
Hhohho Regional Education Officer

Dear Colleague,

RE: REQUEST FOR PERMISSION TO COLLECT DATA FOR UNIVERSITY OF SOUTH AFRICA STUDENT – MR. VUSI F. SITSEBE

1. Reference is made to the above mentioned subjects.

2. The Ministry of Education and Training has received a request from Mr. Vusi F. Sitsebe, a student at the University of South Africa, that in order for him to fulfill his academic requirements at the University of South Africa, he has to collect data (conduct research) and his study or research topic is: *Enhancing Discourse Through Motivation: A Case Study of High School Teaching in Swaziland*. The population for his study comprises of Form 5 pupils from the above mentioned school doing Science. All details concerning the study are stated in the participants' consent form which will have to be signed by all participants before Mr. Sitsebe begins his data collection. Please note that parents will have to consent for all the participants below the age of 18 years participating in this study.

3. The Ministry of Education and Training requests your office to assist Mr. Sitsebe by allowing him to use above mentioned school in the Hhohho as his research site as well as facilitate him by giving him all the support he needs in his data collection process. Data collection period is one month.

DR. SIBONGILE M. MTSHALI-DLAMINI
DIRECTOR OF EDUCATION AND TRAINING

MINISTRY OF EDUCATION TRAINING 2016 -05- 23 BOX 39 MBABANE

cc: Regional Education Officer – Hhohho
Chief Inspector – Secondary
Head Teacher of the above mentioned school
Prof. A. T. Motlhabane

UNISA university of south africa

COLLEGE OF EDUCATION RESEARCH ETHICS REVIEW COMMITTEE

17 February 2016

Ref : 2016/02/17/33466319/28/MC
Student : Mr VF Sitsebe
Student Number : 33466319

Dear Mr Sitsebe

Decision: Ethics Approval

Researcher
Mr VF Sitsebe
Tel: +268 2431 2499
Email: vsisebe@gmail.com

Supervisor
Prof AT Motlhabane
College of Education
Department of Science and Technology
Tel: 012 429 2840
Email: motlhat@unisa.ac.za

Proposal: Enhancing discourse through motivation: A case study of high school teaching in Swaziland

Qualification: D Ed in Curriculum and Instructional Studies

Thank you for the application for research ethics clearance by the College of Education Research Ethics Review Committee for the above mentioned research. Final approval is granted for the duration of the research.

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the College of Education Research Ethics Review Committee on 17 February 2017.

The proposed research may now commence with the proviso that:

1) *The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*
2) *Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the College of Education Ethics Review Committee. An amended application could be requested if there are substantial changes from the*

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www.unisa.ac.za

existing proposal, especially if those changes affect any of the study-related risks for the research participants.

3) The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.

Note:

The reference number **2016/02/17/33486319/28/MC** *should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants, as well as with the College of Education RERC.*

Kind regards,

Dr M Claassens
CHAIRPERSON: CEDU RERC
mcdtc@netactive.co.za

Prof VI McKay
EXECUTIVE DEAN

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