

**EXPLORING FACTORS RELATED TO LEARNER PERFORMANCE IN NATURAL
SCIENCE: A CASE OF A SCHOOL IN THE GAUTENG PROVINCE**

by

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submitted in accordance with the requirements for the degree of

MASTER OF EDUCATION WITH SPECIALISATION IN NATURAL SCIENCE EDUCATION

at the

UNIVERSITY OF SOUTH AFRICA

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OCTOBER 2015

DECLARATION

STUDENT NUMBER: 44327692

I declare that **EXPLORING FACTORS RELATED TO LEARNER PERFORMANCE IN NATURAL SCIENCE: A CASE OF A SCHOOL IN THE GAUTENG PROVINCE** 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.



J S R Anthony

05.10. 2015
Date

ACKNOWLEDGEMENTS

It is an honour for me to thank

- my supervisor Dr PJH Heeralal for his support, inspirational advice and guidance throughout this study
- my editor Mr. Davies Oswald for his patience and knowledge editing of my study.
- Gauteng Department of Education, the school principal, the school governing body members for allowing me to conduct my research study at the school.
- Natural Science teachers and Grade 9 learners for sharing their perceptions and challenges in teaching and learning natural science
- my family for their encouragement towards my completion of this study.

DEDICATION

I dedicate this dissertation to natural science teachers who develop successful science learners.

ABSTRACT

This qualitative study explores the factors related to learner performance in Natural Science and to propose remedial measures to improve such performance. The purpose of this research is to deepen and widen understanding of scientific literacy, science concepts, practical work, graphic organisers and visual representations, incorporated into the classroom as instructional strategies to increase learners' motivation and their learning of science concepts. The natural-science curriculum aims to provide learners with opportunities to make sense of ideas they have about nature. It also encourages learners to ask questions that could lead to further research and investigation. A case study method was used at the research site (school). The Natural science educators' experiences in teaching science concepts, science literacy, science language and compliance with the requirements of Curriculum Assessment Policy Statements were identified by means of document analysis, focus group interviews and completion of a questionnaire. Results indicated several factors that could affect learners' performance in Natural Science including inappropriate teaching strategies, overcrowded classrooms, lack of discipline, inadequate conceptual comprehension, lack of laboratory equipment and resources, non-compliance with Curriculum Assessment Policy Statements, and incomplete or unsatisfactory preparation of teachers' lesson plans. Recommendations and suggestions for further research aimed at addressing the identified factors are indicated. The study concludes with recommendations to improve senior-phase learners' Natural science performance.

KEY TERMS

Academic performance, science literacy, concept, constructivism, content, cognition, pedagogy, assessment, achievement, Natural Science, skills, attitude, principles, performance.

ABBREVIATIONS

AAAS	American Association for the Advancement of Science
ANA	Annual National Assessment
ASs	Assessment Standards
CAPS	Curriculum Assessment Policy Statement
CASS	Continuous Assessment
COs	Critical Outcomes
CORI	Concept-Oriented Reading Instruction
DBA	Department of Basic Education
DoE	Department of Education
FET	Further Education and Training
GET	General Education and Training
ICSU	International Council of Scientific Unions
INSPIRE	Innovation in Science Pursuit for Inspired Research
LOs	Learning Outcomes
NARST	National Association for Research in Science Teaching
NCS	National Curriculum Statement
NRC	National Research Council
NSLA	Natural Science Learning Area
OBE	Outcomes Based Education
OECD	Organisation for Economic Co-operation and Development
RNCS	Revised National Curriculum Statement
SBA	School Based Assessment
PISA	Program for International Student Assessment
TIMSS	Trends in International Mathematics and Science Study

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CHAPTER 1

BACKGROUND, PROBLEM FORMULATION AND AIM

1.1 INTRODUCTION

As noted by Van Rooyen and De Beer (2006), science or rather scientific endeavour is a quest to understand the natural world and how it functions: furthermore, it differs from other disciplines in terms of subject content and methods of gathering, verifying and interpreting information. An urgent need for science education has been driven by a high demand for skilled and creative scientists in South Africa. Science teachers made learners formulate a goal and commit to pursuing it. Nowadays citizens of all ages need to make personal decisions about how they use science and technology (cf. NS Outcome 3). The researcher, Wilkinson (2015), mentioned, in his article, that a research conducted on grade 9 pupils in South Africa showed similar results to the primary school data. Trends in International Mathematics and Science Study (TIMSS) are a cross-national study that measures mathematics and science achievement. The study tested 11 969 pupils in 285 South African schools in 2010 and 2011. Of the 48 countries that participated in TIMSS, South Africa came 47th for mathematics and 48th for science. South Africa's Human Sciences Research Council separated participating schools into 5 groups, ranging from 1 (poorest) to 5 (least poor). Their analysis showed that the least poor 20% of schools significantly outperformed the remaining 80% of schools in both Science and Mathematics. When it comes to a comparison of the curriculum for Maths and Science, it was found that the Revised National Curriculum Statements that guided instruction and learning of mathematics and science at schools during 2002 and 2011 covered more than 90% of the TIMSS assessment framework on which the learners were tested. HSRC executive director and principal investigator of TIMSS Reddy (2012) explains: "This implies that the curriculum for Grade 9 schools in South Africa is on par with the international standard, but there are many other factors that shape achievement at school level". The latest TIMSS (2011) study showed that the average Grade Nine pupil in KwaZulu-Natal was 2.5 years' worth of learning behind the average Grade Nine pupil in the Western Cape for Science, and that the average Grade Nine pupil in the Eastern Cape is 1.8 years' worth of learning behind the average pupil in Gauteng.

A matter of particular concern for the researcher is that at this school few learners are choosing physical science at the FET phase, and very few learners are choosing science subjects at the tertiary level. Moreover learners at the same establishment achieve markedly below-par results for science in their NCS exams. The object of the study under review is to determine the reasons for these poor results.

1.2 BACKGROUND

The Curriculum and Assessment Policy Statement (CAPS) Natural Science Grades 7 – 9 DBE (2011) states that natural science is critical for promoting and developing scientific literacy as learners may elect not to continue with one of the science subjects beyond Grade 9. The study of natural science must enable learners to make sense of the world in scientific terms and prepare them for a continuation of science studies into the FET phase and beyond. So it is important that science teachers motivate senior- phase learners by introducing them to interesting teaching methods and to adopt a problem-centred approach. Teachers also need to promote co-operative learning and actively involve their charges in the presentation of lessons (De Beer & Mtombeni, 1989). Learners typically come to school from a socially disadvantaged background (due to the radical difference between home and school culture), and are burdened to boot with a language barrier in that the language of teaching and learning is alien to their home language. Teachers as facilitators spend time explaining science concepts to learners in their charge and maintain a balance between such explanation and allowing learners to construe their own understanding (Sanders & Kasalu, 2004).

Spaull (2013) mentioned in his report Commissioned by CDE (Centre for Development and Enterprises) that poor quality schooling at the primary and secondary level in South Africa severely limit the youth's capacity to exploit further training opportunities. South Africa's education system is in a dire state, there are a number of recent policies indicate that the Department of Basic Education (DBE) is beginning to address some of the root causes of underperformance. The recent workbook initiative, the Curriculum Assessment Policy Statement (CAPS), the Action Plan to 2030 and the implementation of the ANAs are all moves in the right direction. However, there are still a number of areas which must be addressed if we are to improve the forms of teaching and learning in most South African classrooms, including implement a nation-wide system of diagnostic teacher testing and training and provide a clear articulation of who is responsible for ensuring pupil learning, and to whom, with clear consequences for non-performance. The report highlights a number of

institutional and systemic factors that prevent progress in South Africa's schooling system (NPC, 2012, p. 38). The four most notable of these themes are improve the management of the education system, increase the competence and capacity of school principals, move towards results oriented mutual accountability and improve teacher performance and accountability. Zenex Foundation (2006) *Educating for impact in mathematics, science and language: A ten-year review* states South Africa's education system is facing a major challenge in relation to increasing the output of matriculants who obtain passes in maths and physical science that will afford them access to university. In some cases maths and science teachers are not appropriately distributed and some teachers are not teaching according to their areas of specialisation (HSRC 2011). In 2007 the Department of Education (DoE) introduced the National Policy Framework for Teacher Education and Development into schools and in 2011 the Department of Basic Education (DBE) published the Integrated Strategic Planning Framework for Teacher Education and Development in South Africa 2011-2025. A study by the HSRC (Chisholm et al. 2005) has linked poor school outcomes to teachers spending too little time in the classroom, a lack of subject knowledge and inadequate pedagogical skills especially in the critical areas such as maths, science and languages. Curriculum revision has been a major feature of the restructuring of schooling in South Africa. Since the introduction of outcomes-based education in 1997, there have been a number of revisions that have sought to clarify and streamline the curriculum policy. Curriculum 2005 sought to promote an achievement-oriented, activity-based and learner-centred approach that focused on learning through experience and exploration rather than by rote. Its content was intended to be non-authoritarian, fostering heightened learner participation in classrooms. In 2009, the Minister of Basic Education, Angie Motshekga, initiated a review of the National Curriculum Statement Grades R to 12 in response to numerous concerns raised by teachers about the challenges they experienced in implementing the curriculum. Following this review, the Minister introduced three core policy documents that together provide the curriculum and assessment framework. Among these, the Curriculum and Assessment Policy Statements (CAPS) provide a clear and detailed overview of the content and skills to be taught in each grade and indicate the sequence in which content should be taught as well as the amount of time to be spent on each topic. The CAPS framework was introduced in 2012 in the Foundation Phase and Grade 10, and by 2014 it will be implemented in all grades. This strategy is supported by *Action Plan to 2014: Towards the Realisation of Schooling 2025*, which outlines a targeted approach to improving performance in maths and language competency in Grades 3, 6 and 9, increasing the number of passes in

maths and science, and producing more university entrance passes in Grade 12. The aims of CAPS Natural Science Grades 7 – 9 DBE (2011) states that Careful selection of content, and use of a variety of approaches to teaching and learning Science, should promote understanding of: Science as a discipline that sustains enjoyment and curiosity about the world and natural phenomena. It also states that Natural Sciences at the Senior Phase level lays the basis of further studies in more specific Science disciplines, such as Life Sciences, Physical Sciences, Earth Sciences or Agricultural Sciences. Science as discipline represents particular way of thinking, and communicating scientific ideas is realized by particular linguistic registers (Pappas *et al.*, 2006). Science ideas are not expressed solely through language; instead science is a multimodal discipline that also uses other modes of meaning – visual, gestural, spatial and so forth (Roth, 2009). Different modes of communication offer different affordances, different ways to represent, and different aspects of meaning making (Kress & van Leeuwen, 2006). Thus it was essential to create ways for students to engage in multimodal science experiences in the classroom, which are also part of scientific practice, scientists talk, read, write, use visual images, do hands-on laboratory work (Yore, Hand & Florence, 2004).

Senior-secondary learners (Grades 8 and 9) at this school achieved a poor pass rate in the common Natural Science exam. Grade 9 learners achieved an average of 49% in 2009, 45 % in 2010, 58% in 2011, 46% in 2012 and 47% in 2013. Notably though, they did pass their grade at the end of each term because their exam marks added up to a pass with their Continuous Assessment (CASS) or School Based Assessment marks.

The results of several international and local studies (e.g. Saiduddin, 2003: 22) has shown that achievement at high school tends to differ significantly for urban and rural schools (i.e. rural results are better than urban), while Adell (2002:91) observes that poor performance at high schools is an international problem that has been linked to underperforming learners' disadvantaged socio-economic circumstances. The difference between urban and rural learners' results is endorsed by Munn (1996, cited by Louw, 1993:26).

As noted above, the objectives of the research under review are to explore factors related to learner performance in Natural science, and to deal with these untoward factors to the extent that performance is raised to acceptable levels. Research suggests that learning is more effective when specific aspects of scientific enquiry are identified and taught (Watson, Wood-Robinson & Nicolaou, 2006; Millar, in press). Millar (2009) observes that although teachers use practical activities to help students develop their understanding of scientific

enquiry, the method seems to imply a belief that ‘practice makes perfect’ – “that students will get better at planning and conducting their own investigations simply through practice”.

1.3 THE RESEARCH PROBLEM

The analysis of results from the research site indicates that the learners produce poor scores in their common exams but (in most instances) pass their grade at the end of each term in that their exam marks add up to a pass with their Continuous Assessment or School Based Assessment marks. The exam scores supported by School Based Assessment marks are unsatisfactory because they signify poor specific achievement (cf. Table 4.1). As noted, senior-phase learners at the school serving as the research site have been performing poorly in science. Possible reasons include poor scientific literacy, non-compliance of CAPS, inability to grasp science concepts, as well as misconceptions about scientific matters. Other factors may be deficits that detract from the efficacy of practical work, incompleteness of required formal assessments, difficulties in learning natural science in a second language, learners’ inability to cope with increased academic demands, and of involvement in stimulating academic activities. The formal assessments do not assess the curriculum standards for the grade, teachers’ failure to prepare lesson plan, inadequacy of creative activities with a view to remediation in the sense of improving achievement and attitudes towards science beyond levels achieved with conventional text-based teaching.

1.4 RESEARCH QUESTIONS

The questions generated from the problem statement are as follows:

What are the factors related to learner performance in Natural Science?

- What are Grade 9 learners’ view/perceptions about their performance in Natural Science?
- What are learners’ conceptions (i.e. understanding and usage of scientific concepts) in the learning of Natural Science?
- How do teachers teach selected concepts on scientific literacy?

1.5 AIM OF THE STUDY

The aim of this study is to explore factors related to learner performance in Natural science at the school concerned, and to propose remedial measures to improve such performance.

Primary objectives of the study are as follows:

- Identify Grade 9 learners' views/perceptions about their performance in Natural Science.
- Identify learners' conceptions (i.e. understanding and usage of scientific concepts) in the learning of Natural Science.
- Explore ways teachers teach selected concepts on scientific literacy.

1.6 LITERATURE REVIEW

The Natural Sciences Learning Area is essentially informed by the principle that all learners should have access to science education that will stand them in good stead in coping with the demands they will encounter in their occupational career and in life on the whole. Such an education would have to be learner-centred in the sense that it would have to enable learners to understand and familiarise themselves with scientific subject matter (including environmental and global issues) and the origins of scientific knowledge. Thus the terms of reference envisaged for the Natural sciences Learning Area are essentially informed by the aim to promote scientific literacy and provide a foundation on which learners can build throughout life. (cf. Natural Sciences Learning Area statement).

1.6.1 Curriculum / Scientific literacy

Science teachers are constrained by the curriculum to ensure that learners acquire scientific literacy, to a sufficiently advanced level and can account for the development of the relevant knowledge. More particularly, scientific literacy must be demonstrable as understanding and application of scientific knowledge, understanding of and ability to use scientific approaches and skills, and understanding of the relationships between science, society and the environment, which includes (a) the development of socially responsible attitudes and (b) acting in a responsible way that will not be detrimental to the earth and its habitability (Van Rooyen & De Beer, 2006).

Familiarity with science vocabulary is a critical requirement for the development of adequate levels of scientific literacy (Nelson & Stage, 2007). Note in this regard the trenchant remark that 'science teachers are (among other things) language teachers' (Wellington & Osborne,

2001:5).Sapp (1992:25) argues that science literacy is built on a foundation of information and are the result of successful, specialised information seeking behaviour. Based on this premise, he defined science literacy as ‘active understanding of scientific methods and of social and economic roles of science as they are conveyed through various media. They are therefore built on the ability to acquire, update and use relevant information about science (Sapp 1992:25).

1.6.2 The teaching and learning of science

Stallings’ (1982:19) comments about the relevance of 1970s classroom research concerning science instruction: Every teaching episode has both a curriculum and a delivery system. The delivery system is the process of teaching the curriculum. Curriculum and process are mutually dependent key elements in effective instruction. The most elaborate apparatus money can buy will not compensate for instructional inadequacy. Shulman(1986), who introduced the term ‘pedagogical content knowledge’ in the mid-1980s, suggests that the subject matter of divergent topics calls for appropriately divergent teaching methods. It follows, therefore, that ‘content knowledge’ has to be integrated with ‘pedagogical knowledge’, hence the term ‘pedagogical content knowledge’, denoting teaching methodology that is specially adapted for specific topics within the parameters of a specific teaching discipline.

Company study finds that ‘The available evidence suggests that the main driver of the variation in pupil learning at school is the quality of the teachers’ (Barber & Mourshed, 2007, p. 12), and thus that ‘the quality of an education system cannot exceed the quality of its teachers’ (p. 41).To date, all studies looking at teacher content knowledge in South Africa have been small, isolated project-based inquiries into teacher content knowledge in a particular region. While these are highly instructive and together provide a clear indication that teacher content knowledge is seriously lacking (Taylor &Reddi, 2013 and also Taylor & Taylor, 2013).

Concept-Oriented Reading Instruction(CORI) For nearly 20 years, Guthrie and colleagues have been refining CORI, a programme designed to promote a number of literacy goals through the use of broad interdisciplinary themes (Block & Pressley, (eds)., 2002). CORI has been shown to increase students’ capacity and motivation to learn science concepts, to apply productive methods of inquiry, and to master relevant texts. Improvement was conspicuously noticeable compared to controlled classrooms with separate science and literacy curricula

and/or strategy instruction in reading alone. Of particular interest in the CORI research is the pivotal role that motivation plays across the board (interest, self-efficacy, and achievement motivation) in acceding to science literacy. CORI has been shown to increase students' capacity to assimilate science concepts as well as their motivation to improve their performance at science schooling, and to that end, make proper use of productive strategies/methods of inquiry; and overall text comprehension. Of particular interest in the CORI research is the pivotal role that motivation plays in learning science subject matter and acquiring scientific literacy. The Next Generation Science Standards were released in 2013 to update the national standards for science education released in 1996 and to "combat widespread scientific ignorance, to standardise science teaching across a range of countries, and to raise the number of high school graduates who choose and successfully follow through with scientific and technical majors at tertiary level". The researcher concurs with the frequently expressed sentiment that practical work is central to teaching and learning in science, and that good quality practical work helps develop pupils' understanding of scientific processes and concepts. Millar (2009) observes that the essential purpose of much practical work is to help students to establish associative links between two domains: the domain of objects and observables (things we can see and handle) and the domain of ideas (which we cannot observe directly). Practical work should be consistent in essentials with the principles underpinning science theory and should be designed to promote learners' active participation in and motivation to engage constructively with the subject matter, thus elevating their overall performance at meeting study objectives.

1.6.3 Constructivism in science education

Science education has been strongly influenced by constructivist thinking (Taber, 2009). Constructivism in science education has been informed by an extensive programme of research into students' thinking about and assimilating scientific subject matter. In particular it has been concerned with how teachers can facilitate conceptual change towards canonical scientific thinking. Constructivism emphasises the active role of the learner and the significance of current (i.e. pre-existing) knowledge and understanding in mediating learning, as well as the importance of teaching that provides an optimal level of guidance (Taber, 2011). Allen (2014) explains the idea of constructivism as in order for a new fact or concept to make sense it needs to fit in somewhere with an already established model that has been previously constructed and if it fails to do so it is less probable that the learner will be able to

recall the new information at a later date. These cognitive processes continually take place in the classroom, where pupils will subconsciously and automatically search for existing constructions on which to hang new material that is presented to them in lessons. Some learners ideas will be more aligned with the teacher's original concept than others.

1.7 RESEARCH METHODOLOGY

This study is based on a qualitative, non-experimental, exploratory and descriptive approach (Babbie, 1998) entailing interviews, observation sessions and questionnaires for information gathering. This approach was considered well-suited to capturing educators' and learners' authentic views in order to shed useful light on the process and setting of (infrastructural provision for) science teaching and learning. The information thus gleaned can be used as a basis for remedial action towards overcoming the challenges contributing to poor performance at science teaching and learning at this stage. The present study was designed as a case study. A case study is defined as a design that is suited for the examination of a bounded system, or a case, over time, which employs multiple sources of data found in the setting (McMillan & Schumacher, 2010).

Following the ethical clearance protocols of the university, the researcher obtained permission from the district office, the school principal, the participating teachers and to the parents to conduct two one hour-long interviews with each participant. The researcher also took extra care to secure informed consent from the participants and provided space for exit from the research for those wishing to do so at any stage.

Focus group interview was conducted on the school premises after school hours with three Natural Science teachers to explore ways they teach selected concepts on scientific literacy, their experiences in teaching Natural Science and to determine factors related to senior-phase learners' science performance and remedies to improve the performance of learners who struggle to grasp selected concepts. Focus group interview was conducted with Grade 9 learners on the school premises after school hours to identify their views/perceptions about their performance in Natural Science.

1.7.1 Research design

As noted the study under review was conducted at the school selected as the research site. The researcher works at the research site which is suitable for the research problem and it is accessible for the researcher's resources of time and movement. The information can be

obtained from various sources and informally. A qualitative study of the Grade 9 learners was proposed, using in-depth interviews as the primary research approach. Creswell (2007) defines qualitative research as follows: ‘Qualitative research begins with assumptions, a worldview, the possible use of a theoretical lens, and the study or research problems inquiring into the meaning individuals or groups ascribe to a social or human problem’. Qualitative research provides insight into learners’ feelings, attitudes and thoughts.

As the researcher scheduled to the interviewing process began in the third term of the academic year with unstructured questions. The population for this study consisted of 10 Grade 9 learners and 3 Grade 9 educators. It was anticipated that interviews and necessary follow-up interviews were conducted during that year. The interviews were informal and open-ended, and conducted in a conversational style. The researcher wrote field notes in conjunction with the focus group and follow- up interviews.

1.7.2 Sampling

The target population comprised senior-phase (i.e. Grade 9) learners at the school whose performance had been persistently poor, moderate and meritorious. The authorities at the school gave consent to conduct the proposed investigation. Ten Grade 9 learners and three educators were asked to participate in the study so that the data relating to science-literacy variances that possibly influence learners’ performance and their perceptions about their performance in Natural Science were identified and collected and so that the information were gathered that were conveyed the participants towards science as a subject to study at school.

1.7.3 Data collection techniques

Data collection methods used in this study included documents, questionnaires, and interviews. Parents’ permission for learners to take part in the study was requested in writing. Focus group interviews with ten Grade 9 learners from the school in question were recruited as participants to collect data. Learners’ individual academic as well as their performance as a class, was discounted with a view to randomisation. Five learners with test scores of 50% and higher, and five with scores below 50% were selected. After the focus group interview two

learners participated in a follow-up interview. These two learners were chosen from those who had been interviewed previously. The follow-up interviews were meant to cross-check what learners had said and to ensure that the researcher's impressions were a true reflection of the learners' views. One-on-one interviews were also conducted with each of the three teachers.

Interviews

Interviews solicited the data from each learner, as well as information to determine factors that might influence the learner's use of language, such as his/her socioeconomic environment. Learners were asked to indicate (i) the reason to which they attributed the high rate of failure in science subjects of senior-phase learners in the school, (ii) the reasons to which they attributed the general poor academic performance of learners at their school; and (iii) what they individually considered to be the reasons for their performance/underperformance at science subjects. Questions were formulated as neutrally as possible to eliminate undue extraneous influence. Before data analysis, each interview was transcribed and returned to each interviewee to check for accuracy of the content. The researcher then coded each transcript using predetermined themes following the processes outlined by Tesch (1990), which involves identifying units, categories and themes from the interview data. Data Analysis is the process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data. According to Shamoo and Resnik (2003) various analytic procedures "provide a way of drawing inductive inferences from data and distinguishing the signal (the phenomenon of interest) from the noise (statistical fluctuations) present in the data".

1.7.5 Reliability and validity

Reliability: The researchers' endeavours to interact with learners and gather data generally were informed by the stated need for consistency. The data collection strategy of schedules was reliable for the subjects of this particular research. The sampling procedure was reliable. The researcher was consistent in handling the data (specific questions were answered by participants). In content analysis the researcher consistently coded the same data over a period

of time for stability and accuracy.

Validity: Information was obtained about the participants in the research. The procedural details of the research study were communicated to the participants. The participants and the researcher were in agreement about meanings where mutual understanding was required.

1.7.6 Ethical considerations

All the participants were informed of the purpose of the research study, and all freely agreed to participate. Informed consent was solicited from and vouchsafed by the parents. The researcher tried to establish and maintain dialogues between all participants who were duly informed of all relevant facts concerning the study. The data collected were protected against falsification and theft. The researcher obtained permission from the relevant authorities.

1.8 DEFINITION OF KEY CONCEPTS

Academic performance: A measure of the extent to which a student, teacher or institution has achieved relevant educational goals.

Science literacy: Knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity.

Concept: An abstract or general idea inferred or derived from specific instances.

Constructivism: A theory based on observation and scientific study of how people learn. It is predicated on the view that people construct their own understanding and knowledge of the world in the course of gaining and reflecting on their experience of the world.

Content: The subjects or topics covered in a book or document.

Cognition: The mental action or process of acquiring knowledge and understanding through thought, experience and the senses.

Pedagogy: the method and practice of teaching, especially as an academic subject or theoretical concept.

Assessment: The evaluation or estimation of the nature quality or ability of someone or something.

Achievement: A thing done successfully, typically by effort, courage or skill.

Natural science: A science such as biology, chemistry or physics that deals with the objects, phenomena of laws of nature and the physical world.

Skills: The ability to do something well.

Attitude: A settled way of thinking or feeling about someone or something, typically one that is reflected in a person's behaviour.

Principles: A fundamental truth or proposition that serves as the foundation for a system of belief or behaviour or for a chain of reasoning.

Performance: The action or process of carrying out or accomplishing an action, task or function.

1.9 CHAPTER DIVISION

- * Chapter one encompasses the introduction and background to the study, as well as the formulation of the research problem and the aim of the study.
- * Chapter two comprises a literature review.
- * Chapter three explains the research methodology, outlines the procedure followed to collect data, and discusses matters of reliability, validity and ethical considerations.
- * Chapter four contains the presentation and analysis of data gathered for the empirical study.
- * Chapter five presents findings, recommendations and conclusions of the study.

1.10 SUMMARY

This chapter has adduced evidence to show that scientific literacy is a critical skill that requires the ability to thoroughly comprehend sophisticated scientific concepts that are consistent with state-of-the-art developments or advances in scientific knowledge. Science instruction should inculcate conceptual understanding and develop scientific inquiry. It is incumbent on teachers to resort to a variety of instructional strategies or motivation tools such as cooperative learning strategies and inquiry-based learning to engage students with a view to stimulating their interest and persuading them to strive with intensified interest to master the subject matter (Taylor, 2007). In view of activities prescribed for Grades 5-12 all students should develop the competencies required to conduct an independent scientific inquiry on their own (National Research Council, 1996). Scientific knowledge is essentially created by having students design experiments, construct hypotheses, control variables and justify conclusions.

The 5E learning model, which consists of engage, explore, explain, elaborate and evaluate is widely used as a refinement of earlier learning models, subsequently formalised by Biological Sciences Curriculum Study (BSCS) to use in its curriculum materials (Bybee *et al.* 2006). This model is well researched (Bybee, 1997). It continues to grow in popularity and is becoming infused into domains such as district and state science frameworks, textbooks, science curricular materials, and individual lesson plans in traditional classrooms, college courses, and informal science education settings (Bybee *et al.* 2006). Teachers also use this model in their science teaching to promote teaching and learning.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter comprises a literature review conducted with the object of exploring factors that related to learners' performance in Natural Science at a school in Gauteng, and to propose remedial measures to improve such performance. It has been noted that outdated teaching practices and lack of basic content knowledge have resulted in poor teaching standards caused by overcrowded and classrooms that are poorly equipped for purposes of teaching and learning. The combination of these factors has produced a new generation of teachers who are perpetuating the cycle of mediocrity (DoE, 2001a).Thao Vang (2013) emphasises teachers have to incorporate effective task and activity strategies, such as hands-on and minds-on activities, to keep students focused on guided practice and to keep students engaged in the learning task. Thabo Vang (2013) noted the reference of Roth & Tobin (2007) that says in school, the teacher is essential in facilitating the children's bridging of their own life world knowledge with scientific concepts and language. The focus of this chapter is on communication in the classroom, method of teaching scientific literacy, science constructivism, the importance of practical work in classrooms, responsibilities of science teachers, and the challenges that learners experience in learning will influence learners' performance in Natural Science. This chapter begins with the introduction of a new curriculum which is Curriculum Assessment Policy Statement followed by specific aims of South African curriculum and Natural Science learning area. It will attempt to indicate the possible remedies to improve senior-phase learners' perception about their performance.

2.2 NATURAL SCIENCES IN CAPS

The *National Curriculum Statement Grades R-12 (NCS, 2011)* stipulates policy on curriculum and assessment in the schooling sector. To improve implementation, the National Curriculum Statement was amended, with the amendments coming into effect in January 2012. In this curriculum; the knowledge strands indicated below are used as a tool to organise subject matter relating to natural sciences. Natural Sciences Knowledge Strands are Life and Living, Matter and Materials, Energy and Change, and Planet Earth and Beyond. Each Knowledge Strand is developed progressively across the three years of the Senior Phase. The Knowledge Strands are a tool for organising the subject content. In teaching natural sciences;

it is important to emphasise the links learners need to make with related topics to help them achieve a thorough understanding of the nature and connectedness of subject matter in natural sciences. Links must also be made progressively across grades to all Knowledge Strands (NCS: 2012). From 2006 (NDE 2005) it became compulsory for all learners to take Mathematics irrespective of ability levels. There is a strong emphasis on the natural sciences in South Africa (DoE, 2007). The Natural Sciences Learning Area, which is explained in Curriculum 2005, was tasked with providing the rationale for the inclusion of Natural Sciences (Physical Science, Biology and Physical Geography) in the South African Curriculum. Under Senior Phase Natural Sciences as described in the Curriculum Assessment Policy Statements CAPS Natural Science Grades 7 – 9 DBE (2011), science is declared to be a systematic way of looking for explanations and connecting ideas. Natural Sciences at the Senior Phase level lays the foundation for further studies in more specific science disciplines, such as Life Sciences, Physical Sciences, Earth Sciences or Agricultural Sciences. There are three specific aims in Natural Sciences as per CAPS, DBE (2011), namely doing science, knowing the subject content and making connections, and understanding the uses of science. The learning outcomes (LOs) and Assessment standards are integrated into these specific aims. However lesson outcomes are set for each topic for learners to achieve at the end of the lesson. The specific aims are doing science, knowing the subject content and making connections and understanding the uses of science.

CAPS, Natural Sciences Grade 7-9 DBE (2011) states, the content and the associated concepts must be integrated with the aims and skills for Natural Sciences.

Science process skills:

In the science curriculum it is stated that “*Basic skills are integrated into the competence aims where they contribute to the development of the competence in the subject*” (Dep. 2006) and that “*Arguing for one’s own assessments and giving constructive feedback is an important element in the natural science subject*” (Dep. 2006). CAPS, Natural Sciences Grade 7-9 DBE (2011) states that the following are the cognitive and practical process skills that learners will (presumably) be able to develop as they pass through the course in natural sciences.

1. Accessing and recalling information – being able to use a variety of sources to acquire information, and to remember relevant facts and key ideas, and to build a conceptual framework.

2. Observing – noting objects, organisms and events in detail.
3. Comparing – noting similarities and differences between things.
4. Measuring – using measuring instruments such as rulers, thermometers, clocks and syringes (for volume).
5. Sorting and classifying – applying criteria in order to sort items into a table, mind-map, key, list or other format.
6. Identifying problems and issues – being able to articulate the needs and wants of people in society.
7. Raising questions – being able to think of, and articulate relevant questions about problems, issues, and natural phenomena.
8. Predicting – stating, before an investigation, what you think the results will be for that particular investigation.
9. Hypothesising – putting forward a suggestion or possible explanation to account for certain facts. A hypothesis is used as a basis for further investigation which will prove or disprove the hypothesis.
10. Planning investigations – thinking in advance through the method for an activity or investigation.

The teaching and learning of Natural Sciences involves the development of a range of above process skills that may be used in everyday life, in the community and in the workplace. The National Science Teachers Association's (2011) "21st-Century Skill set includes "core subject knowledge; learning and innovation skills; information, media, and technology skills; life and career skills; adaptability; complex communication and social skills; non-routine problem solving; self management/self-development; and systems thinking" (p. 1).

He defines inquiry as being "about logic, it's about reasoning from data and it's about applying scientific techniques and skills to real-world problems" (Padilla, 2010, p. 8).

Tolman (2002) says two distinct, yet inseparable aspects of science education are the ‘how’ and the ‘what’. Content information is the what, and the process skills collectively are the how of science. He continues that the scientific method of problem solving approaches the process of solving problems in a systematic way. Scientific method is a tool for all teachers and for all students, useful in dealing with everyday, non-scientific problems as well as with scientific questions. Hong and Kang (2010) insist on the perceived need to foster and encourage creativity in science students. The authors argue that science is “ultimately a creative endeavour and most scientific processes involve creativity” (p. 822). McBride and Brewer (2010) then suggest activities that they believe will lead to scientific observations. Advance Organizers are instructional activities or strategies that are used before teaching to help students think about and organize the information they are about to learn and help them to connect prior knowledge to the new information they are about to encounter (Woolfolk, 2011). Organizers generally serve three purposes: they focus students’ attentions to what is coming; they highlight relationships among ideas that will be presented, and they help students make connections between what they already know and the new information to be learned (Woolfolk, 2011).

2.3 SENIOR-PHASE LEARNERS

The General Education and Training Band is made up of a, Foundation, an Intermediate, and a senior phase respectively. Identity includes people’s general sense of themselves along with all their beliefs and attitudes, Identity integrates all the different aspects and roles of the self (Wigfield *et. al.*, 2006). A major goal of formal education is to equip students with the intellectual tools, self-beliefs, and self-regulatory capabilities to educate themselves throughout their life time. The rapid pace of technological change and accelerated growth of knowledge are placing a premium on self- directed learning (Bandura, 2007:10). Children are “naturally inquisitive and begin doing science from the moment of birth by observing and sorting out their world” (Martin, Raynice & Schmidt, 2005:13). As a result of these exploratory experiences, children often come to school with conceptions that are inconsistent with commonly held views of scientific concepts, skills and phenomena.

The teaching time for Natural Sciences has been allocated in the CAPS (2011). The time allocated per topic is a guideline and should be applied flexibly according to circumstances in the classroom and to accommodate the interests of the learners. The new curriculum

emphasises the conceptual, reasoning and communicative competencies. The prescribed CAPS textbooks are according to their cognitive levels.

Millar (1991) has suggested one of the reasons for science being hard to learn

Teachers and schools often erroneously assume that students understand a concept based on the words students use when describing something. Demonstrations used by teachers are often passive where students sit back and observe without manipulating materials or experiencing the phenomenon individually or in small groups. Pictures, diagrams, and 2-dimensional models in textbooks, as well as other instructional materials can be misleading, causing misconceptions. Everyday use of certain terms, often used in non- scientific contexts, contributes to students' confusion. Some words have many different connotations in English, and the "scientific word" can easily be confused with a common use. Some ideas are just too abstract and difficult for many students who are still at a concrete learning stage (e.g. Newton's law of forces).

Vollmer (2007a) mentioned in his case study as language is the basis for developing subject-matter knowledge, at least in a social constructivist manner: This has two meanings - *one* relating to the social origin of scientific knowledge, the *second* relating to the social context of the learning. Language is necessary for identifying and naming concepts, for linking these concepts with one and another and for building up a whole new domain in cognitive and communicative terms. Scientifically literate ways of thinking and acting, however, require the development of higher-order cognitive skills with which to identify ill-defined problems generate a variety solution to problems, act upon informed decisions, and evaluate possible actions and their consequences (Hurd, 1993; Resnick, 1992).

2.4 CONCEPTUAL KNOWLEDGE OF SCIENCE

Hewson(2000) appears to understand dissatisfaction as a product of the intelligibility, plausibility fruitfulness between competing conceptions. The conceptual status constructs which classify a conception as intelligible, plausible or fruitful (Hewson & Lemberger, 2000) is particularly useful for assessing changes to students' conceptions during learning. Motivation involves an individual's choice to engage or not to engage in an activity, persistence in the activity, intensity throughout the activity, and the resultant increase in the quality of the activity (Maehr,2003). Thus, motivation should be central in the development of any sound educational program. This research will explore how students' motivation and interest in creative, curriculum-based, hands-on activities affect their conceptual understanding of science (NRC, 2009). Stevens and Bransford (2007) advice that the

importance of the 'informal' education sector has been well documented in recent years (NRC, 2009). Recent literature in science education indicates that there is a relationship between motivation, cognitive engagement, and conceptual change (De Backer and Nelson, 2005). This study will explore how students' motivation and interest in creative, curriculum-based, hands-on activities affect their conceptual understanding of science. The Sciences 3-18 Education Scotland (2012) Good practice Example 15 considers one school has been given a substantial area of land by a local business to maintain, develop and use as 'outdoor classroom'. From the National Sciences Education Standards, National Research Council (1995) there is less emphasis on knowing scientific facts and information, studying subject matter disciplines (physical, life and earth sciences) for their own sake, separating science knowledge and science processes, covering many science topics and implementing inquiry as a set of processes. The objectives of science instruction at all levels should be conceptual understanding and scientific inquiry (Gabel, 2003). Conceptual change literature has now expanded the conceptual change model to include the influence of the individual's motivation for learning (Pintrich, 2004). The Concept development in the sciences (2009) describes progression in the development of knowledge and understanding of some of the scientific concepts which are contained within the experiences and outcomes as children and young people learn within a level and then move to the next. In a recent review of science education research Fensham (2001) addressed the limitations of conceptual change as follows: Another weakness in the range of alternative conceptions is that the focus in most relevant studies is on isolated concepts of science, rather than on the contexts and processes of conceptualisation and nominalisation that led to their invention in science. (p. 30).

Conceptual change elaborates on the theory of constructivism and refers to the process learners go through in "...coming to comprehend and accept ideas because they are seen as intelligible and rational" (Posner, Strike, Hewson, & Gertzog, 1982, p. 212). "The conceptual change model is widely accepted among science educators. Though there are competing views of how conceptual change occurs, there seems to be no argument about whether conceptual change occurs; it is central to learning in science" (Suping, 2003, Conclusions section, Para. 1). Although teaching for conceptual change is challenging, it is an attainable goal and has proven benefits for learning. In this style of learning, children confront the inconsistencies in their scientific knowledge, and gain a deeper understanding of science content (Watson & Kopniecek, 1990). Teaching for conceptual change will take time; it is a worthy pursuit that will indeed assist in achieving scientific literacy for all children (NRC,

1996). In schools especially in rural areas learners face disadvantages in terms of the lack of visual demonstrations of the topic that is being taught. Teachers' use of nonverbal gestures or graphic representations convey understandings of science concepts and benefit all students regardless of cultural and linguistic background (Best, Dockerell & Braisby, 2006). Conceptual change refers to the reorganising of current conceptual knowledge in the face of conflicting new information (De Backer: 2005). Cox (2012) says that when fiction and non-fiction books are integrated into teaching of a content area such as science, graphic organisers are useful for organising information and enabling students to classify observations and facts, comprehend the relationships among phenomena, draw conclusions, develop explanations and generalize scientific concepts. Charts and other graphic organisers are known to be effective aids for students who are struggling with learning content or learning difficulties, regardless of grade level (Guastello, Beasley & Sinatra, 2000). Visual presentations are an important and integral part of conveying the purport of science concepts – both in the laboratory and when engaging a public audience. Images often serve as the primary evidence supporting the claims of a scientific publication (Johnson, 2007). Goal theory identifies learning goals or learning goal orientation as important in the acquisition of conceptual understanding (Alao & Guthrie: 2000). The motivation goal of pleasing the teacher, parents or peers is a variable of interest in current motivational literature because it does seem to have an impact on students' academic successes (De Backer & Nelson: 2005).

2.5 SCIENTIFIC LITERACY

Thao Vang (2013) says in science, literacy is more than the ability to read and write; it means students are able to comprehend, apply, and understand science words in scientific processes. Similarly in PISA (Program for International Student Assessment), scientific literacy is defined as:

an individual's scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science-related issues, understanding of the characteristic features of science as a form of human knowledge and enquiry, awareness of how science and technology shape our material, intellectual, and cultural environments, and willingness to engage in science-related issues, and with the issues of science, as a reflective citizen (OECD, 2009, p.14).

As Trefil and O'Brien-Trefil (2009) noted teachers can help students become part of society's science conversations by using real-world applications of science in instruction and by inviting students to discuss and debate relevant and motivating content. When teacher teaches the concept forces, the teacher uses a variety of real world examples to encourage learners to participate actively so that they understand the concept. For example a car travels at a high speed can be stopped by the force of the brakes on the wheels. According to Osborne (2000) and Norris and Philips (2003) contend that the term scientific literacy has been used to include various components such as the knowledge of the substantive content of science and the ability to distinguish such content from non-science. In PISA 2009 (OECD, 2010a, b) the top scores in science scores followed each other in close order and were well above the OECD average. The results indicate self-evidently that nurturing high performance while addressing low performance at the same time need not be mutually exclusive and that excellence in mathematics and science requires excellence in reading. Holbrook and Rannikmae (2007) suggest the effectiveness of teaching of science subjects depends on science literacy. The teaching thrust for this form of scientific literacy has been described as education through science and contrasted with science through education. Pappas (2013) says children engaged with texts, material objects, dialogue, ideas and symbols in the various curriculum genres enacted in their classroom community they were supported, bridging their own understandings and ways of multimodal communication with those of the scientific community. In doing so children became learners of both science and literacy.

Science literacy instruction should engage children and youth in making sense of scientific texts as one form of scientific inquiry. When reading and writing are cast as tools for investigating phenomena, students can learn how to build on and expand the work of other scientists by reading about the designs and findings of others (Cervetti & Pearson 2006). McNeill, (2006), Moje *et al.* (2004) teachers regularly ask students to evaluate whether their written claims refer back to the hypotheses they made, whether they made the data evident, and whether they have provided reasoning for their claims. Students can also learn to use writing in the way that scientists do for both journaling and public reporting (McNeill & Lizotte 2006). In short, literacy has a role to play in both firsthand (hands-on) and second and (text-based) investigations. Over time and through scientific inquiry, hypotheses may become facts. *Exemplary science in Grades 9-12* (Yarer, 2005) states that students learn science best when they are actively engaged in matters of vital interest to them. *Inquiry-based science education comprises* experiences that enable students to develop understanding about the scientific aspects of the world through the development and use of inquiry skills (Harlen &

Allende, 2009:11).It will also form a viable basis, should the need arise, for remaining in work related to science or technology in later careers (Millar & Osborne 1998, p. 9).The science needed to solve the problems of everyday life, they argue, is very different from that presented via the school curriculum. This argument has prompted Fensham (2002) to state that it is ‘time to change drivers for scientific literacy’ and to abandon the traditional ways of identifying science content for the school curriculum.

ICSU (2011) A number of programmes in place in different countries have sought to take advantage of the natural curiosity of young children to encourage further development of inquiry and the scientific process, as well as excitement about the potential of careers in scientific disciplines. The Government of India has recently launched a very ambitious programme in 2008, INSPIRE, in consultation with the Indian National Science Academy and other Science and Engineering Academies, to attract and motivate a large number of young students to opt for a career in science. These INSPIRE camps will each have a session for counselling parents on the attractiveness of careers in science and research.

2.6 CONSTRUCTIVISM IN SCIENCE EDUCATION

Science education has been strongly influenced by constructivist thinking (Taber, Keith S: 2009). Constructivism in science education has been informed by an extensive programme of research into students’ thinking and reasoning about scientific subject matter, and in particular exploring how teachers can facilitate conceptual change towards canonical scientific thinking. Constructivism emphasises the active role of the learner and the significance of current knowledge and understanding in mediating learning, as well as the importance of teaching that provides an optimal level of guidance(Taber, 2011).Constructivism is the major plank in the contemporary aggiornamento proposals; it is a strategic programme that has implications for various tactical-level reforms. In 1991 the president of the US National Association for Research in Science Teaching (NARST) said: “A unification of thinking, research, curriculum development, and teacher education appears to now be occurring under the theme of constructivism... there is a lack of polarised debate” (Yeany 1991, p. 1). Scientific knowledge as public knowledge is constructed and communicated through the culture and social institutions of science. (Driver et al 1994) Constructivism is not a specific pedagogy. However, student learning is maximized when constructivism is used as a *referent* for science teaching (Lorsbach, A, W., &Tobin, K. 1992).

All teachers need to be scientifically literate and preferably excited about science. (National Academics of Science, 2007, p.121). Many individual views on science learning refer to how the social environment might influence learning (Driver et al, 1994; Leach & Scott, 2003) scientific knowledge can only be learned through some process of social transmission. (Leach & Scott, 2003) Therefore much consideration should be given to how the knowledge to be taught is introduced in the social environment of the classroom, and how individual students become able to use that knowledge for themselves. (Driver et al, 1994; Leach & Scott, 2003). Student performance can improve when instruction is designed to deal with specific difficulties revealed in studies of students' pre instructional knowledge. (Savinainen & Scott 2002).

A recent review has identified at least the following varieties: contextual, dialectical, empirical, information-processing, methodological, moderate, Piagetian post epistemological, pragmatic and radical, realist, social and socio historical (Good Wandersee & St Julien, 1993). To this list could be added humanistic constructivism (Cheung & Taylor 1991) and didactic constructivism. Constructivism, from its origins in developmental psychology, has spread to encompass, often naively, many domains of educational inquiry. Constructivism emphasises that science is a creative human endeavour which is historically and culturally conditioned, and that its knowledge claims are not absolute. In some of the *National Curriculum Statement* documents there is a persistent emphasis on learner construction of knowledge, notably in the Life Sciences (Umalusi, 2009a: 54). This no doubt stems from the *Curriculum 2005* emphasis on constructivism as a learning theory. For teachers to encourage creativity beyond set outcomes, constructivist pedagogy is needed to facilitate and encourage thinking via the processes used to engage students with the content, as well as the content itself. Constructivist pedagogy models aim to develop learning by promoting the virtues of an individual's search for meaning, as much as the knowledge being gained from that search. The creation of knowledge from experience and the use of that knowledge to support new learning represent fundamental principles of constructivism. Furthermore, it is vital to note that there are two perspectives (cognitive and social) on constructivism which are inextricably linked to the enhancement of pedagogy, based on critical and creative thinking (Cooper, 2007).

2.7 THE IMPORTANCE OF LANGUAGE IN SCIENCE EDUCATION

Wellington and Osborne(2001)say that the focus of secondary education has largely been on science as a practical subject, often quite rightly, for science is partly an empirical subject. But for many pupils the greatest obstacle in learning science – and also the most important achievement – is to learn its language. One of the important features of science is the richness of the words and terms it uses. Pupils should learn the language of science so that they can read critically and actively and develop an interest in reading about science; and develop competence in sceptically scrutinising claims and arguments made in the press and on television based on ‘scientific research’ or ‘scientific evidence’. Jenny Lewis (2007b) demonstrates promising ways of helping students from all backgrounds and with different experiences to construct their own understandings and ideas, before they are led to more scientific views and explanations afterwards. Vollmer (2007a) says language is the basis for developing subject-matter knowledge, at least in a social constructivist manner: This has two meanings - *one* relating to the social origin of scientific knowledge, the *second* relating to the social context of the learning. Subject- specific language use and communication do not form a goal in themselves, rather they are closely linked to *what* is being communicated (the content or subject-matter) and *how* a specific concept or insight has been *processed* and *obtained* (the cognitive activities involved). Lee et al. (2013)suggest that teachers promote academic language acquisition through “supporting students’ ability to do things with language, engaging them in purposeful activities, and providing them with opportunities for language use” using “task based instruction” (p. 6).Academic language in science includes formulating hypotheses, designing investigations, collecting and interpreting data, drawing conclusions, and communicating results (Chamot & O’Malley, 1994; National Research Council[NRC] 2000). Additionally, science employs non-technical terms that have meanings unique to scientific contexts (e.g., matter, force, energy, space).Science time in schools is often limited, and as a result teachers find it difficult to include science vocabulary instruction to help students make sense of texts(Kragler, 2005). In addition, teachers are often eager to teach content, and consequently provide only a brief gloss of science terms. Johnson (1987, 2005, 2007) proposes that image schemas structure our experience pre-conceptually. Science learning needs the effective use of language. Psychologists know of the intimate relation between language and thought. Language is more than a way of labelling things around us; it is a tool that aids conceptualisation. Language adds meaning to, and aids interpretation of experience. Research on the role of language in science learning has led to better understanding of metaphor and analogy, and of how meaning is drawn from science

activities (Sutton, 1992).Halliday (2004) discusses grammatical problems occurring in scientific discourses conducted in English. In any typical group of science students there will be some who find themselves in difficulty – who find the disciplines relating to physics, or biology forbidding and obscure. When teachers try to diagnose their problems the focus of discussion is more than likely to turn to language issues. Language is central in Vygotsky's theory, so it is important that students understand and use the “language of science”.

Wellington and Osborne (2001) note that “science teachers are (among other things) language teachers”. By using scientific terms and phrases during science activities; science educators can model scientific thinking and questioning, affording insight into the doubts and dilemmas that are part of making sense of the world.

2.8 RESPONSIBILITIES OF THE SCIENCE TEACHER

Bennett(2011) talks about the local schools, learners and teachers. Like most people teachers' acquaintance with science is usually where they left it after their university days updated possibly from their own interests and occasional in-service updating courses. Evidence continues to emerge that a teacher's views of the world and of teaching and learning, as well as his/her beliefs about knowledge and intelligence will inevitably affect the nature and quality of teaching (e.g., Kennedy, 1998). As noted by Trefil and O'Brien-Trefil (2009), such introspection should provide the foundation of young people's scientific literacy and related social responsibility. The constructivism provides a perspective on teaching and learning science in classrooms, with a view to improving the effectiveness of science teaching in enhancing students' learning. Gabel (1999) identified several effective strategies for learning science. These include: learning cycle approach, Science/Technology/Society, Yager (1996), Real-life Situations, discrepant events, Analogies, Collaborative Learning, Wait-Time, Concept mapping Inquiry and Mathematical Problem Solving. In order to predict how learners will respond to attempts to teach science it is necessary to understand their preinstructional knowledge, the knowledge that students bring to a given teaching situation. (Leach & Scott, 2003). In constructivists' view teachers in science classrooms as authority figures play two essential roles. The other is to listen and diagnose the ways in which the instructional activities are being interpreted to inform further action. (Driver et al, 1994). Teacher intervention like and the ongoing interactions between teacher and students constitute a teaching and learning 'performance' on the social plane of the classroom (Leach & Scott,

2003). Science teachers play crucial roles in science learning of students not only by making scientific culture tools available to students, but also by guiding and constructing the knowledge with their students through discourse about shared practices, Miha Lee (2006).

According to Gillispie (1992), “*Science* connotes both the knowledge contained in such disciplines as astronomy, physics, chemistry, biology, and geology and the activities involved in obtaining it.” In many countries around the world teachers do not undergo sufficient training to teach scientific subjects – on the contrary, their inadequacy as teachers may do more to drive learners away than to attract them to the field (OECD, 2008). Some teachers lack a basic understanding of the mathematical and scientific concepts that form the basis of scientific expertise that will be expected of tomorrow’s scientists. Teachers need to organise various assessments and feedback to stimulate learners’ interest in science. The Teaching and Learning Research Programme (2006) states that science is unique among school subjects in that its curriculum aims to create future scientists rather than the future citizen. Learning and teaching methods, the curriculum, as well as assessment, are all highly influential in forming student attitudes towards science, as is the quality of teaching to which they are exposed.

Research has shown that one of the crucial obstacles to effective teaching and learning is the loss of teaching time (Chisholm *et al.*, 2005). In the light of in-service training, the National Policy on Teacher Education (RSA 2007 section 48) states that ‘All teachers need to enhance their skills, not necessarily qualifications, for the delivery of new curriculum’. These training inputs are bound to benefit curriculum coverage and learning outcomes. Teachers need to have a clear understanding of the role of integration within their learning programmes. The key, however, is the balance to be struck between integration and conceptual progression. Teachers must therefore be aware of and look for opportunities for integration both within and across learning areas (RNCS, DoE 2003). Where OBE is concerned teachers will have to plan lessons based on the stipulated specific aim and lesson outcomes envisaged for the relevant learning area. The focus will therefore be on achieving the critical and learning outcomes. Teachers should have a thorough knowledge of the relevant curriculum models as an aid to constructive planning for the clear benefit of the learner. Newton, Driver and Osborne (1999) suggest that the development of discussion within school science is dependent on four prerequisites – advanced planning, appropriate time slots, a prerequisite knowledge base, and establishment of clear procedures for running group discussions. All teachers hold personal beliefs and dispositions about teaching, learning, and learners. According to the analysis proposed by Vygotsky (1962, 1978) from the viewpoint of socio

cultural psychology the teacher's role is based on a conceptualisation of teaching as 'assisting performance'; a notion that is linked to individual student learning through the concept of the 'Zone of proximal Development'(ZPD) (Vygotsky, 1978). Bearing in mind these basic aspects of Vygotsky's socio cultural theory, teachers guide the discourse of the inter psychological plane to support student learning with particular reference to the forms of pedagogical intervention undertaken by teachers to support students' development and understanding of scientific knowledge.

According to Jacobs, Vakalisa and Gawe (2004) teaching strategy refers to a series of teaching-learning actions that are designed by teachers to help learners achieve a prescribed learning outcome. A teaching method is a procedure that can be used by the teacher when presenting the learning content to learners. According to Washington (2003) vocabulary instruction is effective when it includes visual, verbal, and physical support; therefore, physical scaffolding is critical in content-area teaching. Bennett (2011) says that, like most other people, for the majority of teachers their science is where they left it after their university days, updated possibly from their own interests and occasional in-service updating course. CAPS, DBE (2011), the cognitive demands of assessment should be appropriate to the age and developmental level of the learners in the grade. Assessments of performance at natural sciences must cater for learners' divergent range of cognitive levels and abilities of learners.

Resources

Tobin(1992), states that teachers' purpose is to provide the best materials and learning situations to make learning individually meaningful for each student. "A good textbook contains, in a single source, a comprehensive study programme for the year- it lays the curriculum out systematically providing expositions of the concepts, definitions of the terms and symbols of the subject in question, worked examples of standard and non-standard problems, lots of graded exercises, and answers" (Taylor 2008). Each content, concept, topics of Natural Sciences and even text books activities should be indicated with the respective specific aims to achieve the set lesson outcomes. The research site is a rural school in that it was under-resourced and present in a poor parent community.

In CAPS Natural Science Grades 7 - 9 DBE (2011) the resources needed for teaching Natural Sciences are listed against each topic in order to assist teachers with planning and

preparation. Integrated learning is central to outcomes-based education. The key, however, is the balance to be struck between integration and conceptual progression. That is, integration must support conceptual development rather than being introduced for its own sake. Teachers must therefore be aware of and look for opportunities for integration both within and across Learning Areas (RNCS, DoE 2003).

Bloom's Taxonomy (NCS, South Africa, Department of Education 2003; CAPS, DoE2011).

Knowledge, Understanding, Application, Analysis and Synthesis are descriptive words to help teachers discern various levels of cognitive learning. The aim is to move students from lower levels to higher levels of cognitive development.

Students' interaction with science words enables them to grasp the full meaning of the words and the gist of the relevant discourse.

2.9 RELATIONSHIP BETWEEN EDUCATIONAL THEORY AND PRACTICE

Newton, Driver and Osborne (1999) classify models of teaching and learning respectively as transmission, discovery and serial constructivist types. At present, educational policy in South Africa seems to be largely taken in tow by outside forces that are dominant pacesetters in determining the conceptualisation of education as a construct in the mind of officialdom as well as the public at large. Consider, for example, the idealistic neo-liberal claim that education should prepare workers for a specific type or sector of the job market. This conceptualisation runs counter to the more conventional notion that education should be acquired for its own sake, rather than for a seemingly extrinsic reason such as financial prosperity. More and more, education and schooling seem to be about the abilities/skills that are inculcated during life at school. Furthermore, in the higher education sector there is an extraordinary emphasis on skills instead of the type of people/teachers that should be developed (November 2005). Subjects such as mathematics and the sciences are prioritised. Hoadley (2012): The Science Curriculum Framework is derived from the policy framework for teaching and learning. Central to the curriculum framework is the inculcation of the spirit of scientific inquiry.

2.10 PURPOSE OF PRACTICAL WORK IN SCIENCE TEACHING

CAPS Natural Science Grades 7 – 9 DBE (2011) states that, every learner should have access to sufficient workspace and equipment to carry out investigations. For safety and educational reasons it is recommended that no more than three learners share the same space and equipment. Research, however, tends to suggest that more effective learning occurs when specific aspects of scientific enquiry are identified and taught (Watson & Wood, 2006). A variety of terms exist to describe practical work, many of which are frequently used with little clarification. For example: Several terms are used with little attempt to explain their meaning in *Science in the National Curriculum*, e.g. ‘practical and enquiry skills’, ‘practical and investigative activities’, ‘independent enquiry’ and ‘experimental work’(QCA 2007a/b).

Gott and Mashiter (1994) advocate a task-based approach to curriculum design which would motivate learners and give them a sense of ownership of activities. The aim of science education was to fill that mind with the ‘truths’ of science. ‘The aim does not lie in the discovery process[But in] the understanding of certain basic concepts’ (Woolnough 1998a). In practice the Nuffield approach became restrictively prescriptive in the hands of teachers who lacked grounding in philosophy (Woolnough, 1988). Millar (2004) argues that it is important to realise that in most countries the school science curriculum aims to provide every young person with sufficient understanding of science to engage the modern world confidently and effectively – a ‘scientific literacy’ aim. School science provides the foundations for more advanced study leading to such jobs. (p. 2, Abrahams & Millar 2008, forthcoming).

Evidence of effective use of practical work comes from a range of studies. White and Gunstone’s study(1992) indicates that ‘students must manipulate ideas as well as materials in the school laboratory (Lunetta *et al.* 2007). There is a growing body of research that shows the effectiveness of ‘hands-on’ and ‘brains-on’ activities inside and outside the laboratory. Summing up the findings of their recently published research into laboratory work, Lunetta *et al.* (2007) conclude: When well-planned and effectively implemented science education, including laboratory and simulation experiences, situate students’ learning in varying levels of inquiry requiring students to be both mentally and physically engaged in ways that are not possible in other science education experiences (p. 405). They go on to explain that the laboratory can be ‘particularly well suited for providing a meaningful context for learning, determining and challenging students’ deeply held ideas about natural phenomena, and constructing and reconstructing their ideas’ (Lunetta *et al.* 2007, p. 406). Concerning a pedagogical approach they contend the following: ‘Social learning theory makes clear the

importance of promoting group work in the laboratory so that meaningful, conceptually focused dialogue can take place among students as well as between teachers and students' (p. 406). Science teachers in United Kingdom are not alone in reporting lack of time as a barrier to doing more practical work. For example, a recent small-scale study in Hong Kong found that '*science teachers generally find inquiry-based laboratory work very difficult to manage*' and that the seven teachers in the researcher's study 'were most concerned about the lack of class time, shortage of effective instructional materials, and the need to teach large classes' (Cheung, 2008, p. 107).

Millar, noting that students need to think as well as act, referred to the observation by Duckworth (1990) that tasks were accomplished effectively when the learners executing them were not only '*hands on*' but also '*minds on*' (Millar: 2004, p. 12). The starting point for improving practical work is therefore to help teachers become much clearer than many are at present about the learning objectives of the practical tasks they use. CAPS Natural Science Grades 7 – 9 DBE (2011) states that although it is not considered ideal to improvise equipment, teachers should remember that it is more important for learners to have the experience of carrying out a variety of investigations than to depend on the availability of equipment.

2.11 MOTIVATE SENIOR-PHASE LEARNERS TO LEARN NATURAL SCIENCE

It would be extremely difficult for someone to learn a skill without relevant prior knowledge, whether visual or verbal. Also called the verbal-motor stage because it involves information processing (Adams, 1971, Schmidt & Lee, 2005), the cognitive stage, is of great interest to cognitivists because it involves the conveyance (verbal) and acquisition (cognition) of new information. During the cognitive stage it is important that the learner be provided with information and guidance, and that sufficient time be allowed to establish sound intellectual fundamentals. Jacobs, Vakalisa and Gawe (2004) maintain that the success of a teaching method is determined by the teacher's motivation, the effort that the teacher puts into the unit or lesson, the motivation of the learners, and the ability of the teacher to create exciting opportunities for the learners. Science tasks that offer little or no challenge are unlikely to motivate students to learn (Moeed, 2010).

Driver et al (1994) emphasized that the role of the science teacher is to mediate scientific knowledge for students, to help them to make personal sense of the ways in which knowledge claims are generated and validated rather than to organize individual sense-making about the natural world. Teachers use specialized terms and concepts; they show specialized procedure and skills. According to the Schools Bill (1996) the pillars of this movement are that all educators must teach, all learners must learn, every school must have a basic resources package, all governing bodies must be elected and must work, no crime will be allowed and all governing bodies, educational and learner organisations will be encouraged to underwrite a bill of rights pertaining to education. The report of the Sciences 3-18(2012) Curriculum Impact Project contains a range of examples of how working with partners to provide well-planned learning experiences can enhance learning and teaching and impact positively on outcomes for children and young people. “Building the Curriculum 3 (2008) defines the curriculum as the ‘totality of experiences which are planned for children and young people throughout their education, whenever they are being educated’”. Padilla (2010, p. 9) states that “inquiry teaching is an approach that engages student curiosity and wonder, that inspires students to observe and reason and that helps them to sharpen their critical thinking and communication abilities”.

The report of the Sciences 3-18 (Oct 23-2012), Curriculum Impact Project covers the planning of senior-phase teaching and articulation thereof with broad general education. One of the identified aspects for development of planning and delivering the sciences at the senior phase is articulated as follows: ‘Secondary schools need to finalise their plans for the senior phase and ensure that learning at the broad general education phase will articulate with their senior phase’. Halliday (2004) suggests seven headings under which to illustrate and discuss the typical difficulties that E2L learners may face in dealing with interlocking definitions, technical taxonomies, special expressions, lexical density, syntactic ambiguity, grammatical metaphor and semantic discontinuity. ETDETDP SETA CAREER GUIDANCE (2012)states the public school teaching is difficult at present, but government has been working for many years to improve conditions. School and classroom conditions, professional solidarity among teachers, as well as student/family background conditions, are directly relevant as co determinants of students’ learning. In the focus group interview teachers mentioned critical challenges, including overcrowded classrooms, absence of teacher training in the use of alternative methodologies, and lack of resources to support learners who need more assistance. Fitzgerald (2013) says if the student does not find science motivational, they are not likely to engage with it. Some barriers to learning can be overcome through student interest, thus promoting engagement and perseverance.

2.12 SUMMARY

The researcher's review identified factors like scientific literacy, understanding of science concepts, practical work and effective strategies for learning science. The researcher also reviewed the characteristics of senior-phase learners, described the layout/structure of the area of natural science learning, the role of senior-phase teachers in facilitating learning, and the purport of the national curriculum statements. The aim of science instruction at all levels should be conceptual understanding and scientific inquiry. Unfortunately, certain segments of the population equate science achievement with how well students score on science exams (Goodlad, 1998). Scientists frequently ask questions as hypotheses and then use certain processes (such as making observations, inferences, or predictions; classifying; controlling variables; measuring; and making charts and graphs) to draw conclusions. Students can use inquiry not only to deepen their conceptual understanding of a given topic, but also to learn the same processes that scientists use in discovering new knowledge. Inquiry was thought to be such an essential component of science instruction in K-12 schools that it is stressed in the *National Science Education Standards* (1995) however, note that a companion volume titled *Inquiry and the National Science Education, Standards*, was published in 2000.

Moreover, the three learning outcomes (LOs) and associated assessment standards (ASs) for the natural science learning area are stated in the form of specific aims in the policy and therefore need to form an integral part of any learning program. OBE is an outcomes-based approach used to deliver the curriculum. The CAPS spells out specific content (topics and sub-topics), as well as what is expected annually, per term and even daily in some cases. Teachers design learning activities with a view to for achieving all the Lesson outcomes.

Bloom (1956) developed his taxonomy of objectives exclusively for the cognitive domain, an exercise that could prove useful in providing structure for planning activities. For example, science teachers use higher cognitive objectives for higher grades, including even analysis, synthesis and evaluation. This chapter indicates the factors that contribute to the learners' better understanding of natural science concepts and the variety of teaching strategies that can be used in science classrooms. Chapter 3 deals with the investigation method to explore the reasons for senior-phase learners' performance in Natural Science.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

A qualitative research methodology was used for this study. This study employed a case study research design in which factors related to learners' performance in Natural Science were explored. This qualitative research method is best suited to a project where the variables are unknown and need to be explored (Creswell 2012). The Literature reviewed in the previous chapter facilitated the researcher to build up significance, to identify methodological limitations and to propose research theory. The research design, sampling techniques, data collection procedures, interviews and limitations are discussed in this chapter.

3.2 RESEARCH DESIGN

In this study the researcher aimed to explore the factors behind learners' poor performance and to improve such performance. A qualitative study tends to focus on exploring smaller numbers of participants for in-depth illumination. A case study is the method of choice when the matter at issue does not stand out prominently from its background (Yin 2003: 4). The modus to adopt, then, will comprise analysis of unstructured interviews, followed by theoretical deduction. It is most appropriate when the researcher wants to become more familiar with the phenomenon of interest, to achieve a deep understanding of how people think about a topic, and to describe the perspectives of participants in thoroughgoing detail.

3.3 QUALITATIVE RESEARCH

According to Creswell (2012), research characteristics differ in essentials at each stage of the research process of exploring a problem and developing a detailed understanding of a central phenomenon. The researcher chose this qualitative research design because the researcher searched and explored with a case study method until deep understanding was achieved. This study highlights the important role of teachers in the development of science learning and

learners performance, and in present science-teaching strategies that reflect how science is actually practiced.

3.4 CASE STUDY APPROACH

Case study researchers are less likely to identify a cultural theme – especially anthropology - to examine at the beginning of a study; instead, they focus on an in-depth exploration of the actual ‘case’ (Yin, 2008). A case study is an in-depth exploration of a bounded system (e.g. activity, event, process, or individuals) based on extensive data collection (Creswell, 2007).

The researcher chose to use a case study as a research instrument to serve the evident need to develop a holistic understanding of learners’ performance in science. The qualitative case study is appropriate for the researcher’s study of investigating how teachers can improve learners’ performance in science, and what strategies they can employ to meet students’ developmental needs. The data collected by making use of an unstructured interview/focus group interview administered according to an interview schedule. A questionnaire was used to collect data. The layout of a questionnaire was easy to read, and in correct logical sequence. The data were collected from documents such as work schedules, mark recording tool and lesson preparation. The focus group interviews were determined whether the lesson preparation is in-line with work schedule. The questionnaires were indicated the challenges in teaching science concepts and practical activities in the school at issue. The conceptual framework of this study is conceptual understanding of science integrating practical work with science theories, scientific literacy and effective instruction strategies that will promote learners’ performance in science.

3.5 IMPORTANCE OF STUDY

The purpose of this study was to explore factors leading to learner performance in Natural Science at the school concerned, and to propose remedial measures to improve such performance. The researcher reviewed literature and established specific connection between existing knowledge and the research problem were investigated and the literature provided the methodology that can be incorporated into a new theory, The researcher explored few of the factors through the literature reviewed, identified Grade 9 learners’ perceptions about their performance in Natural Science, learners’ conceptions in the learning of Natural science and explored ways teachers teach selected concepts on scientific literacy. The results of the TIMSS 2011 assessment (HSRC, 2012), which showed that at the Grade 9 level an

increase of 60 points was recorded for mathematics and science. Yet despite this ray of hope South Africa still ranked among the bottom three countries of the forty-five that participated in the assessment, scoring below the 400-point benchmark level. Some of the TIMSS underperformance may well be due to a mismatch between the local curriculum and TIMSS coverage: according to the HSRC (2012) the overlap at the time of 9 assessments could amount to 70% for mathematics and 55% for science. After conducting large-scale econometric studies of the drivers of education performance the Social Policy Research Group in the Department of Economics at Stellenbosch University reported the following (Van der Berg *et al.*, 2011): ‘South Africa’s rural children did far worse than rural children in most other countries ... as did the poorest quarter of South African students in comparison with the other countries in the sample’ (idem: 4) - a result that is at variance with the fact that South Africa’s teachers are ‘better qualified’ and the pupil-teacher ratio is lower than in peer countries. ‘While teacher knowledge was lower in poorer than in richer schools, it made little difference to learner performance’ (idem: 5). It is puzzling, therefore, that the Department of Education (DBE, 2012a) claims that the undergraduate ‘success rate’ for whites is only 10% higher than that achieved by members of SA black populations. Hoadley (2012): The Science Curriculum Framework is derived from the policy framework for teaching and learning. The National Research Council (NRC) is responsible for National Science Education. The importance of engaging children in active participation in processes of scientific inquiry is evident in the NSES from statements such as “Learning science is something students do, not something that is done to them” and “Science teaching most involves students in inquiry-oriented investigations in which they interact with their teachers and peers” (NRC, 1996, p. 20).

Literature relating to conceptual change has now expanded the conceptual change model to include the influence of the individual’s motivation to teach (Pintrich, *et al.* 2004); therefore the teacher must not only present a rationale for conceptual change, but must enhance the quality of the engagement. The looked-for result in this instance would be better conceptual understanding on the learner’s part. The Pintrich study showed that science learning can be promoted by practical work or scientific inquiry, appurtenant conceptual changes, effective instruction strategies and visual representations. Smith (2011) says teaching science became a holistic approach to teaching; science learning was essentially about curiosity, willingness to question, and an intrinsic need to seek understanding. So interpersonal and collaborative learning became very important. Teachers can use code switching and explain in their home language to make learners understand the science concepts. Learners from this school are coming from informal settlements and their teaching and learning language is second language. So to make them understand the concepts teachers have to use various teaching strategies. Wellington and Osborne (2001) note that “science teachers are (among other

things) language teachers”. By using scientific terms and phrases during science activities; science educators can model scientific thinking and questioning, affording insight into the doubts and dilemmas that are part of making sense of the world. Denicolo (2014) states that the level of impact can be attributed to how frequently the outcome is evident in each of the observed groups. The area of enquiry set up for this study was the project of furthering understanding of science concepts, integrating practical work with science theories, acquiring scientific literacy, and effective instruction strategies to promote learners’ performance in science learning.

3.6 CONTRIBUTION TO THEORY AND PRACTICE

Case study design is appropriate for exploratory research entailing examination of the factors that promote teaching and learning of senior-phase learners. The study in hand is set up to ensure that the content, process, language and pedagogical practices of the curriculum are age appropriate; and within the cognitive reach of the child. This study explored the poor scientific literacy, non-compliance of CAPS lead to learners’ performance in Natural Science. Teaching and learning are complex, context-dependent processes that need to be described in their full complexity in order to understand and ultimately claim control of them (White, R., 2001; Berliner, D C, 2002).

Denicolo (2014) states that the results of measuring impact from perspective studies can be used to measure and inform, and hence are particularly good for constructing or adapting policy or procedures. They can be used to identify better alternatives if the impact assessment is not satisfactory or not delivering on policy decisions. Case studies can be linked to action because they build on actual practices and experiences; hence the insights they produce can be instrumental in changing practice for the better. Indeed a case study may be a sub-set of a broader action research project (Cohen *et al.* 2000: 184).The researcher is confident that this study will be instrumental in generating new theory that will improve teaching and learning for both teachers and learners by casting the educational paradigm in a new mould that proceeds from a more proactive premise.

3.7 ROLE OF THE RESEARCHER

McMillan and Schumacher (2010) say that qualitative researchers often change their role in the course of data collection. They continue that quality researchers provide for the logical

extension of findings which enables others to understand similar situations and apply the findings in subsequent research or practical situations. The nature and duration of roles are determined in part by the situations concerned. The researcher's professional that enable her to understand and familiar with the participants. The researcher was actively involved in the activities attending the study under review and spent a considerable amount of time observing the natural day-to-day habits of the participants. According to McMillan and Schumacher (2010) participatory research requires planning of the dual role of participant and researcher, which usually imposes narrowly restrictive limits on the findings. So the researcher in charge of conducting the study participates in the interview, analysing documents such as work schedule, school based assessment, mark recording tool, lesson plan and records the data.

3.8 QUALITATIVE SAMPLING STRATEGY

This study employed a case study that was exploratory did not need many persons. This study focused at one site the researcher repeatedly returning to the same informants looking for confirmation. Literature reviewed and analysed the research problem and research questions recommended the type of settings and interviews that were informative. The researcher got permission to use the research site, teaching staff and learners after the school hours. Ten Grade 9 learners were involved in the study under review. Grade 9 learners were selected to reflect a broad variety of characteristics such as language, grasping science concepts, taking an active interest in practical work, and setting goals for careers in science. Purposive sampling is used regardless of the kind of data concerned. Qualitative sampling, in correct to probability sampling, is a matter of selecting information-rich cases for in-depth study (Patton, 2002, p. 242) with a view to gaining insight into them without having to generalise to all cases. In purposive sampling the researcher intentionally selects individuals with a view to gaining knowledge of and insight into the main concern of the study. The researcher chose only ten Grade 9 learners and three Natural Science teachers because they were information rich in that they were knowledgeable and informative about the subject at issue. Sample size was chosen to accord with study purpose which is to explore factors related to Grade 9 learners' performance and their perception towards Natural Science.

Site Selection

The research site was a combined school situated in Gauteng Province, and catering for Grades R to Grade 12. The school was inadequately equipped for science teaching activities (i.e. equipment, classrooms and furniture were in short supply). Science laboratories were used by different subject teachers who took turns to teach different subjects for lack of classrooms. Teachers' profiles were received during the pre-interview. As a staff member at the chosen research site the researcher was familiar with the senior-phase natural science teachers; moreover the science classroom was chosen as the more specific venue in order to ensure the presence of senior-phase learners with a view to pursuing the main purpose of the research, namely to isolate the factors that significantly influenced learners' performance in Natural Science. The qualitative data collection consisted of lengthy periods of gathering information at the chosen venue, to which end permission had obtained at various levels to allow the direct access needed for the purpose.

Participants

Participants in this study were Grade 9 learners and senior-phase Natural Science teachers. As noted, permission had obtained at various levels to enable such participation. The researcher naturally played a significant part in selecting participants, again as noted, in a process of purposive or non-random sampling with a view to giving precedence to information-rich participants in the interest of probing the inner recesses of the research issue (Patton, 2002). The researcher chose ten Grade 9 learners and three senior-phase Natural Science teachers to make up the study sample, serve as focus-group participants and respond to the questionnaire.

Data sources

The primary data sources utilised in the present instance included the senior-phase natural science learners, the researcher and three natural science teachers. Literature reviews, interviews, questionnaires, and document analysis were the main data collection techniques employed for the purposes of the study under review.

Interviews

McMillan and Schumacher (2001) observe that focus group interviews are used to obtain a better understanding of a problem, or of an assessment of a problem, or of a concern, or a new product, programme or idea. According to Shneiderman and Plaisant (2005) interviews can

be most rewarding since the interviewer can pursue specific issues of concern that may lead to focused and constructive suggestions. As noted by Shneiderman and Plaisant (2005), the main advantages of this method of data collection are that direct contact with the users, which often leads to specific, constructive suggestions, are well-suited to eliciting detailed information, besides which few participants are needed to gather rich and detailed data. Kumar (1996) notes that an unstructured or in-depth interview is conducted with due reference to a prepared framework (interview guide) provided by the interviewer who formulates questions according to such framework. Denicolo (2014) states that using an individual interview as the primary or only means of collecting data takes considerable time and effort but can yield in-depth and rich data. Learners were exposed to unstructured interviews to discover their perceptions about their performance in Natural Science. Teachers were interviewed as well to find out the ways they teach selected concepts on scientific literacy.

Document analysis

Their work schedule, incompleteness of lesson preparation, School Based Assessment, and compliance with CAPS senior phase 2011 were analysed and discussed. According to CAPS (2011) the teachers should focus on the specific aims of Natural Science. It provides the work schedule consists of learning-area contents and a conceptual frame work with required learning aims geared to specific grades. Lesson preparation should be correlated with work schedule. These documents were reviewed in the study at issue. Examination of the following was included in the investigation.

Questionnaires

McMillan and Schumacher (2001) define a questionnaire as relatively economical in that the same questions are posed to all participants and anonymity can be assured. Face-to-face surveys may get better response rates but are more time consuming for the researcher. A pilot study was conducted in the present instance in order to improve the chosen data-gathering strategy to best advantage. The questionnaire reflected learners' interests in science, practical, understanding of science concepts, and perception of science.

Data collection procedures

Unstructured interviewing and focus group techniques are qualitative methods of data collection (Bowling, 1997: 311). The researcher chose a small sample for the study under review. Senior-phase Natural Science teachers were interviewed to find out whether their impressions of the science content were reflected in their teaching. The researcher also collected data gained from student and teacher interviews conducted to a prepared questionnaire, and from classroom materials.

3.9 VALIDITY

Most rationalists would contend that instead of a single, core reality, so to speak, a personal, unique reality is constructed by everybody who applies his/her mind to the matter (Smith & Ragan, 2005). Thus, where interpretation is concerned understanding is co-created and there is no objective truth or reality that can serve as a definitive yardstick against which a study and its conclusions and findings can be measured. However, credibility can be checked against feedback obtained from participants about their responses to the researcher's investigations. Merriam (ibid) provides the following strategies to give credence to qualitative research in the sense of internal validity:

- Triangulation – using multiple sources of data or techniques to confirm findings.
- Member checks – taking data and tentative interpretations back to the people from whom they were derived and asking those if the results are plausible.

Triangulation arose from an ethical need to confirm the validity of research processes, and in case studies such confirmation can be achieved by using multiple sources of data (Yin, 2003) (e.g. participant observation, focus groups, member checking). Triangulation is one of the most important ways to improve the trustworthiness of qualitative research findings.

In the present context critical reliance is placed on triangulation as a means to evaluate the outcome of the study. Based on the evaluation instruments, focus group and individual interviews were conducted with students. The outcomes of the focus group interviews were triangulated with the user-satisfaction survey completed by the students, as well as with the reports of experts (staff members). The focus group interview with teachers indicated the challenges confronting the task of teaching science concepts in a language medium that is not the learners' home language, and learners' related lack of understanding of science language (specialised or 'technical' language used in dealing with scientific subject matter). Learners actively participate in practical through SBA (School Based Assessment) which requires three practical tasks and 2 tests during the first term, 2 practical tasks, 1 test and an exam during the second term, three practical tasks and two tests during the third term, and three practical tasks, a test and an exam during the fourth term. At the end of the year the marks

achieved in all these assessment procedures are added to calculate a promotional mark for each learner. In this way the procedures involved in SBA are used to develop learners' skills, knowledge and attitudes and thus achieve the goals set for OBE (outcomes-based education) and CAPS senior-phase (2011). So learners are developed who possess the skills, knowledge and attitudes that are prerequisites to satisfy the demands of outcomes-based education.

3.10 RELIABILITY

According to Merriam (1998) the decisive criterion for reliability is the extent to which research findings can be replicated (p. 205) with similar subjects in a similar context. It is a critically important measure determined by the researcher to account for or describe the changing contexts and circumstances that are fundamental to consistency of the research outcome. Merriam (1998) suggests that reliability in this type of research should be determined by whether the results are consistent with the data collected. The following techniques are applied to that end: explain the assumptions and theory behind the study, triangulate (i.e. cross-check data) by using multiple methods of data collection and analysis, and explain in detail how data were collected in order to make provision for the contingency of an audit trail.

The research study correlated well with the chosen methodology. This study is repeatable by any other researcher. The focus group interviews with senior-phase natural science teachers revealed that learners' poor conceptual understanding was the essential reason for their poor performance in natural science. Natural science subject policy, work schedule and lesson preparation were reviewed for compliance with the CAPS senior-phase document.

3.11 ETHICAL CONSIDERATIONS

The practices and protocols before and after the data collection are parental permission, assurance of children's voluntary participation, children's agreement, children's safety environment during the data collection process and secure anonymity of data. The researcher received ethical clearance from UNISA. The researcher requested permission from the Ekurhuleni south district to conduct the study in the school and the request was duly granted. The school principal was informed by submitting a copy of a permission letter to conduct a

study. The senior-phase Natural Science teachers were informed about the study and requested to participate in a focus group interview. The Grade 9 learners were given a youth assent form and received back the acknowledgement. Sufficient information provided to undergird a reasoned decision, and consent was voluntary and openly declared. The data were collected after the ethical implications had been duly considered and the approach had been approved by the appropriate mechanism in the institution. As this being a qualitative study, the researcher had to interact in depth with participants and teachers, thus entering their personal domains of values, weaknesses, individual learning disabilities and the like to collect data. Understandably, this raises several ethical issues that should be addressed during and after the research. Bias on the part of the researcher is unethical. Being ethical means adhering to the code of conduct that has been evolved over the years for an acceptable professional practice.

3.12 SUMMARY

This chapter has outlined the research paradigm, research methodologies, strategies and design used in the study, including procedures, participants, data collection tools, data collection and analysis methods, and data credibility issues. The research tool used for this study was an exploratory and interpretive case study that was analysed largely through qualitative methods and the data analysis, presentation of data, and presentation of data findings are followed in Chapter 4.

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

4.1 INTRODUCTION

McMillan and Schumacher (2010) describe qualitative analysis is a relatively systematic process of coding, categorizing, and interpreting data to provide explanations of a single phenomenon of interest which was suitable for this case. As Merriam (2009) notes with emphasis qualitative data analysis and collection occur together, qualitative data collection and analysis usually proceed simultaneously; and findings that emerge as the research continues have a determining influence on the types of data collected and the methods employed to do so. In this chapter the data gathered from focus group interviews with Natural Science teachers and learners are represented and described. The data collected through focus group interview with learners' were inductively analysed by transcribing with the view to establish categories emerging from the teachers' practices of facilitating learning when teaching science concepts in relation to the learners' conceptions in the learning of Natural Science. From the focus group interview with Natural Science teachers were analyzed to get data about teachers way of teaching certain concepts in scientific literacy. Documents such as work schedule and lesson plan were analysed to get more data about teachers' comply with CAPS(2011).

4.1.1 DATA COLLECTION

On the basis of the requirements of CAPS (2011) and the teaching of scientific literacy in the classroom data was collected to

- explore the factors related to learner performance in Natural Science
- determine Grade 9 learners perception about their performance in Natural Science
- identify learners conceptions (i.e. Understanding and usage of scientific concepts) in the learning of Natural Science
- Identify the ways teachers teach science concepts in scientific literacy.

The Natural Science teachers are familiar with CAPS (2011). As it implemented recently January 2012, teachers were used to the Revised National Curriculum statements with learning outcomes and assessment standards, they have to practice by integrate them into

specific aims, and the increased assessments which is required in CAPS (2011). They must accept the changes, overcome the challenges and try to meet the requirements of CAPS (2011). The focus group interviews with teachers and learners were used to get how teachers teach science concepts and Grade 9 learners conceptions in the learning of Natural Science. The questionnaire got how far the Natural Science teachers compliance with CAPS (2011) and their experiences with the changes.

4.2 Data obtained from Natural Science teachers and learners

Results mentioned in this chapter are based on

- Document analysis (Grade 9 lesson plan, School Based Assessment and mark recording tool)
- Focus group interviews (3 Natural Science teachers and ten Grade 9 learners)
- Questionnaire (3 Natural Science teachers and ten Grade 9 learners)

Documents analysis were done with work schedule, lesson plan, School Based Assessments and the mark recording tool to determine the compliance with CAPS (2011). Hoadley (2012) remarks that the syllabus is based on the science curriculum framework, and emphasises the need for a balance to be struck in allocating time and effort to the acquisition of science knowledge and the concomitant skills and attitudes. Teachers are provided with Senior-phase Natural Sciences CAPS (2011) document, which consists of Senior-phase Natural Science curriculum delivery processes. The work schedule is provided in CAPS(2011) in the form of Natural Sciences Contents and Concepts for Grade 7 – Grade 9. It stipulates time allocation, topic, content and concepts, suggested activities and necessary resources. Therefore teacher should follow this as guidelines for successful teaching and learning. The teachers should be guided with specific aims for each content and concepts. Tolman (2002) mentioned in teaching, success literally hangs in the balance of planning. The teacher who is well prepared is able to be alert to on-the-spot needs as they rise. Carl (2010) says the planning function appears to be a basic function but it involves the process of micro-curriculum planning which consists of Goals, content, objectives, methods and techniques, education media, learner activities and evaluation before implement the lesson. Natural Sciences CAPS (2011) illustrates how the specific aims and lesson outcomes should be integrated in teaching and learning of Natural Science in classrooms.

The focus group interviews with Natural Science teachers provided with data whereby their challenges of using CAPS (2011) as their guidelines For example: increased assessments.

Multiple types of data can be collected during a focus group interview, including audiotape recordings of participants' responses (Krueger, 1994). Tape-based analysis is used to analyse data from a focus group, with the researcher listening to the recorded focus group responses of which s/he makes an abridged transcript. Krueger (1994) notes that this type of analysis is helpful because the researcher can focus on the research question and only transcribe what assists understanding of the relevant phenomenon. In light of learners' performance in Natural Science, data were collected with the aid of a focus group interview conducted with teachers to establish

- teachers' perceptions and experiences in teaching Natural Science
- what teaching strategies are used in the classroom
- Different documents were used as reference materials to prepare a lesson
- The interview was used, further, to discover how to integrate practical work into science lessons to
- improve learners science literacy and language
- to aid lesson preparation in line with the work schedule;
- to assist school- based assessment tasks and the recording tool;
- to aid compliance with CAPS (2011); to guide teachers changed CAPS terminologies; and
- to assist provision of subject support materials such as a demarcated natural science work schedule, school- based assessment tasks, and a detailed CAPS lesson plan format.

Data were collected from Grade 9 learners to explore

- the factors leading to their Natural Science performance
- the difficulties they experience in understanding science concepts
- the reasons why a preference for to prefer physical science can be considered more rewarding than life science
- the level of their interest if any, in practical activities
- the type of support they required from educators and
- the science disciplines they would like to choose in the FET phase

The questionnaire provided the data concerning factors and perceptions in regards to Natural Science by teachers and the understanding of science concepts by learners. The researcher developed an interview schedule that was compiled separately for educators and learners respectively.

4.3 Data analysis

McMillan and Schumacher (2010) note that inductive analysis is the process through which qualitative researchers synthesis and extract meaning from the data by deriving categories and patterns from specific data. Content analysis allows the researcher to test theoretical issues to enhance understanding of the data. Content analysis enables the distillation of words into fewer content related categories.

4.3.1 Findings derived from document analysis, the focus group interview and the questionnaire

In analysing the data the researchers read and independently sorted responses elicited from learners as well as their educators. In sorting the responses, statements projecting similar ideas were grouped together. The following documents were analysed: Compliance with CAPS Natural Science Grades 7 – 9 DBE (2011), work schedule, lesson preparation, and school- based assessment. Table 4.1 shows the Grade 9 learners’ Natural Science performance in past 5 years proved that more learners passed in the SBA / CASS tasks than the exams due to poor conceptual understanding resulting in the low pass rate at the end of the year.

Table 4.1 Grade 9 learners’ Natural Science performance

Year	No. wrote	No. passed in CASS / SBA	No. passed in Exam only	No. passed at the end of the year	Percentage promoted
2009	230	180	40	113	49
2010	220	150	39	99	45
2011	230	170	50	133	58
2012	220	175	32	101	46
2013	230	165	42	108	47

Source: Records of Natural science teacher, Research site.

4.3.1.1 Compliance with CAPS Natural Science Grades 7 – 9 DBE (2011)

CAPS Natural Science Grades 7 – 9 DBE (2011), lesson plan templates are provided to teachers but they are not filled up. A copy of the lesson plan is given below:

NATURAL SCIENCE LESSON PLAN CAPS SENIOR PHASE

DATE:		H.O.D./DEP.PRINCIPAL:			
TOPIC: Cells as the basic units of life		LEARNERS MUST BE ABLE TO:			
THEME: Cell structure		<ul style="list-style-type: none"> • make a 3-dimensional (3D) model of a cell • draw, label and describe the structure of plant and animal cells and the functions of their organelles 			
SPECIFIC AIMS	1. DOING SCIENCE				
	2. KNOWING THE SUBJECT CONTENT & MAKING CONNECTIONS				
	3. UNDERSTANDING THE USES OF SCIENCES & INDIGENOUS KNOWLEDGE				
CONTENT	RESOURCES	APPROACH	LEARNER ACTIVITIES	ASSESSMENT	
				FORMAL	INFORMAL
<ul style="list-style-type: none"> • the cell is the basic structural and functional unit of all living organisms. Cells can be seen under a microscope (they are microscopic) • plant and animal cells have a cell membrane, cytoplasm, nucleus, and organelles such as mitochondria, vacuoles and chloroplasts -- the <i>cell membrane</i> encloses the contents of the cell. It allows specific substances to pass into and out of the cell -- the <i>cytoplasm</i> is the jelly-like medium in which many chemical reactions take place -- the <i>nucleus</i> contains DNA o the nucleus is enclosed by a <i>nuclear membrane</i> (in plants and animals) o DNA contains inherited characteristics, such as whether eyes are blue or brown o DNA is unique to each person; this <i>variation</i> accounts for differences within species -- <i>Mitochondria</i> are responsible for respiration to release energy from food 	<ul style="list-style-type: none"> • Textbooks and other reference material • 3 dimensional (3D) model of a cell, and/or pictures 	HINT: Use a statement or question to stimulate discussion amongst learners. Use models, films, investigations etc.	<ul style="list-style-type: none"> • Activities from workbook/textbook can be used or self-designed. State the activity: 		
HOMEWORK	INDICATE TEXTBOOK/WORKBOOK BEING USED. ES WORKBOOK – PAGE				
SUPPORT/ENRICHMENT	RE-TEACH		TEXT ADAPTATION		PROF.GUESTS
	INDIVIDUAL ATT.		HANDS-ON APPLICATIONS		RESEARCH
	CORRECTIVE TEACHING		PEER INTERACTION		HIGH ORDER QUESTIONS
	VISUAL AIDS		ENGAGING NEW MATERIAL		ADDITIONAL ACTIVITIES
TEACHER REFLECTION					

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As Tolman (2002) says ‘to fail to prepare is to prepare to fail’ is true of teaching; success literally hangs in the balance of planning. The above lesson plan templates were not filled up with dates, activities and resources. Teachers need guidance in regards to the integration of learning outcomes and associated assessment standards into specific aims. These incompleteness of lesson plans indicating the teachers are non-compliance with CAPS (2011).As per National Curriculum, in CAPS DBE (2011) the terms ‘Learning Outcomes’ and ‘Assessment Standards’ have been replaced with ‘content’ and ‘skills’. There is no evidence of using work schedule which is in the form of contents and concepts in CAPS(2011) but they know how to teach the knowledge strands i.e. life and living content in term 1; matter and materials in term 2; energy and change in term 3; and planets and earth beyond in term 4. Teachers offered the following explanations during focus group interview for not filling the lesson-plan template.

“I don’t have time due to my heavy work load; I have to teach many classes of different grades.”

“In my perspective lesson plan looks like a repetition of my work; it looks like my daily forecast, depend upon my learners absorption I will prepare.”

“I have filled for last term; but I haven’t received it from my subject facilitator for this term.”

Van Der Horst and McDonald (1997) note that the daily lesson plan could be very brief. For instance, a unit may be operated as a laboratory. In such cases the procedure may be simply to help and guide learners’ endeavours as they do their laboratory work. Jacobs, Vakalisa and Gawe (2004) observe that lesson preparation resembles a journey in that teachers need to plan the ‘journey’ of teaching by taking account of various contextual factors such as learners, teachers, classroom, learning content, school, environment and community. Teachers formulate outcomes but the CAPS lesson plan indicates the unit outcome for each lesson or topic. Once the outcomes have been clearly defined, the teacher has to make sure that the classroom activities have been aligned with those outcomes. Alignment is seen as a central component of outcomes-based education since it promotes the matching of learning

outcomes with the teaching-learning activities (Van der Horst & McDonald 1997). Carl (2010) notes that teachers are largely responsible for lesson planning in the classroom, to which end they must identify and formulate objectives, analyse content, plan learning experiences, consider teaching methods and the sequence of constructional learning events and evaluate them effectively.

Responses to question 33 show that all classroom activities are knitted together by the teaching strategy that the teacher uses to help the learners attain the desired learning outcomes. Learners' activities are calculated to meet the respective natural science learning outcomes and their associated assessment standards.

Here are some illustrative responses:

“Encyclopaedia, text books and teachers from other schools teaching the same subject”

“Text books, CAPS document and internet also”;

“Text books, CAPS document etc.”

Jacobs, Vakalisa and Gawe (2004) observe that textbooks have become an almost inseparable part of the present school system; however, lesson planning should proceed from learners' prior knowledge and the intended learning outcomes of the lesson. Abrahams and Millar (2008, forthcoming) argue that ‘teachers need to devote more lesson time to helping students use ideas associated with the phenomena they have produced, rather than seeing the successful production of the phenomenon as an end in itself.’ As Du Plessis (2007) says, “the school must be ready for the learner rather than the learner being ready for the school”. So that teachers don't lose any of their instruction time for better performance.

Table 4.2 Section A. Educators' biographical and background details

1	Gender	Male	Female			
	Responses	2	1			
2	Age	20-30	30-40	40-50	50-60	
	Responses		1	2		
	Ethnicity	B	W	C	I	Others

3	Responses	3					
5	Years of Teaching experience	1	2-3	4-8	9-12	13-20	Over 20
	Responses				1		2
6	Experience as natural science teacher	1	2-3	4-8	9-12	13-20	Over 20
	Responses				1	1	1
7	Highest Academic / professional qualification	Teacher's Diploma		Higher Teacher's Diploma	Bachelor Degree(s)	Post-Graduate Degree(s)	Others
	Responses				2	1	
8	The grade you are currently teaching	Grades 8 - 12		7 – 9			
	Responses	2		1			
9	Status of your post	Permanent		Temporary	SGB post		
	Responses	1		2			
9	Your teaching level at school	Post level 1		Post level 2	Post level 3	Post level 4	
	Responses	3					
10	Type of School you are teaching	Public school		Private school	Others		

	Responses	3									
11	Language of teaching and learning	Afrikaans		English		others					
	Responses	3									
12	Your province	G	KZN	M	NW	L	FS	WC	EC	NC	
	Responses	3									

From their responses the researcher noted that among three educators two of them are male and one female educator. One of the teachers belongs to age group of 30 – 40 and other two teachers belong to age group 40 – 50. The three Natural Science teachers are from Black population. One of the teachers completed their Post graduate studies and the other two teachers are Bachelor degree holders. This is a public school and they are teaching not only natural science but other subjects as well. Teacher 1 has a permanent post level 1 at this school and teaches Life Science and natural science for more than ten years. Teacher 2 teaches physical science and natural science for twelve years, and teacher 3 teaches natural science for more than twenty years, however they both hold level 1 temporary post. The three teachers at this public school are from Gauteng and their language of teaching is English. Although the focus group interview is audio taped and/or videotaped, the tape is used primarily to verify subjects’ utterances of interest to the researcher, and perchance later to gather more information.

The researcher used the following scale for the focus group interview with teachers

1: strongly disagree	2: Disagree	3: Neutral/undecided	4: Agree	5: Strongly agree	6: N/A
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Table 4.3 Section B Educators’ responses of their perception towards natural science teaching in the classroom

	Questions		SD	D	N	A	SA	N/A
13	You are well trained in terms of the prescribed standards required by CAPS Senior Phase Natural Sciences (2011).	n	0	0	0	0	3	0
14	You know the aims of NCS Gr. R-12(2012)	n	0	0	0	1	2	0
15	You are well-acquainted with specific aims of	n	0	0	0	1	2	0

	Natural Sciences stipulated in CAPS (2011)							
16	You know how to handle senior-phase learners.	n	0	0	0	1	2	0
17	You know all science process skills and use it for learners.	n	0	0	0	1	2	0
18	You set activities with science process skills.	n	0	0	0	1	2	0
19	You try to clear away learners' misconceptions about science concepts.	n	0	0	0	1	2	0
20	You motivate learners to attend science programs	n	0	0	1	1	1	0
21	You vary the teaching strategies that you use in the classroom.	n	0	0	0	2	1	0
22	You emphasis conceptual change to improve teaching and learning	n	0	0	1	1	1	0

Teachers' comments on CAPS, elicited during the focus group interview included the following:

"In CAPS some of grade 9 content is encountered in grade 11; it is too much for our Grade 9 but it is improved from last NCS document Grade 8 content is just fine"

"CAPS is effective; easy to handle; the content is given in detail"

"CAPS is not a problem for us; in the matter of time we will adjust for that, it is like OBE and NCS but it is revised";

According to the national curriculum, CAPS (2011) is a revision of the current National Curriculum Statement (NCS). The CAPS (2011) was introduced to undergird the National Curriculum Statement in order to improve the quality of teaching and learning. Every subject in each grade will have a single, comprehensive and concise policy document that will provide details on what teachers need to teach and assess for each grade and subject, the object in each case being to lessen the administrative load on teachers and ensure that they have clear and consistent guidelines to follow when teaching. With CAPS each teacher will

know what and when to teach, and how to do assessment. Ekurhuleni South district provided training on CAPS (2011) and encouraged the teachers to accept the changes and advices them to follow it. The responses of question 13 proved that the three teachers are well trained on how to use CAPS (2011). The teachers' responses to question 14 shows that two teachers are more aware of National Curriculum statements than the other teacher. The responses to question 15 shows that two are more familiar than the other teacher with the specific aims stipulated in CAPS (2011).The responses to Question 16 show that two teachers are more skilled in handling senior-phase learners than the other teacher. In Erikson's Eight Stages of Psychological Development the senior-phase learners are at the 5th stage, characterised by identity versus role confusion. Throughout adolescence, changes in the brain increase abilities to control behaviour that are notably absent in many learners-a key deficiency (Wigfield *et al.* 2006). The responses to question 17 show that two teachers are well known of science process skills. The CAPS Natural Sciences Grades 7-9 (2011) lists 15 very specific Science process skills that learners must master in the senior phase and are stated in chapter 2 section 2.2.The responses to question 18 show that two teachers set activities that include science process skills and the other teacher use them in some of the activities. Thao Vang (2013) says that there are many ways to teach and practice science concepts, but the proper way to engage students in learning inquiry science is through the inquiry process skills, as indicated in Chapter 2 section 2.2.He continues teachers need to require students to practice inquiry skills to learn scientific processes. Tolman (2002) says first seven of these process skills are basic processes, while the last three are integrated processes. It would be helpful if we could identify activities for teaching each of the processes in isolation, with methods that involves one and only one process.

The responses to question 19 show that two teachers try to clear learners' misconceptions unless several misconceptions are linked together in the mind of a learner in a sensible way. Allen(2014, p.5) says identification of a pupil's misconceptions is often the easy part for teachers, with correction being more complex and less attainable. He continues, in order to facilitate meaningful learning it is preferable that at the start of a topic or lesson teachers try to discover their pupils' current ideas that are relevant to the science concepts that are about to be introduced. The responses to question 20 shows that one teacher encouraged learners to participate science programs such as science Olympiad and Science Expos and one teacher is not at all interested in such programs. Science programs provide learners to grow with skills, knowledge and attitudes. ICSU (2011) States, Science and Mathematics Olympiads, science fairs and Young Scientist competitions are alternative approaches that serve to stimulate

interest and encourage recruitment, and are equally valuable for improving science literacy and the development of science process skills for some young people ICSU (2011). The responses to question 21 show that one teacher uses various teaching strategies in the Natural Science classroom. Pappas *et al*(2013) Children’s learning is facilitated by the multitude of communicative modes used in the science lessons. Teachers and children engaged with text (written and oral), pictures, physical objects, bodily performances, semantic maps and murals. Responses to question (22) show that teachers do not always emphasise conceptual change to improve teaching and learning. Harlen (1992) notes that teaching science to children means enabling them to engage in scientific exploration that leads to understanding. The Department of Education (2002a: 9) describes, with special reference to all teachers’ functions, the envisaged kind of teacher for South Africa. Literature relating to conceptual change has now expanded the conceptual change model to include the influence of the individual’s motivation to teach (Pintrich, *et al.* 2004); therefore the teacher must not only present a rationale for conceptual change, but must enhance the quality of the engagement. The responses to question 23 show that the teachers connect real world examples into their teaching. Fitzgerald (2013) say some students find little relevance or application for the science they do at school. Selecting science topics that relevant and connect with students’ experience can generate interest, engagement and perseverance in science. The responses to question 24 show that the teachers are not using code switching as the research site is a English medium school and the first language and language of teaching and learning is English.

Responses to question 30 – 32 clearly show that there are incompleteness of assessments. CAPS Natural Science Grades 7 – 9 DBE(2011),states formal assessment tasks and tests form part of a year-long formal programme of assessment in each grade and subject. The SBA component in the senior-phase (Grades 7 – 9) amounts to40% of formal schooling, while the year-end examination contributes60% towards promotion of the learner. Formal assessment requirements for natural sciences are a practical task and a test for each term as indicated CAPS Natural Science Grades 7 – 9 DBE (2011) for the senior phase, while the mark recording tool required three practical and two tests per term. So learners were not submitting all the tasks. Poor performance is associated with this deficient compliance. Appendices J, K and L show the differences between CAPS and the said alternative.

Table 4.4 Educators’ responses of their ways of teaching science concepts on scientific literacy

23	You use illustrative real-life examples to teach science concepts to learners.	n	0	0	0	3	0	0
24	You use code switching to facilitate teaching where the language of learning and teaching is not the same as the learners' home language.	n	0	2	0	1	0	0
25	Your learners are provided with resources, if not you make supplementary/remedial booklets for them	n	0	0	1	1	1	0
26	You use Bloom's taxonomy in your assessment to develop learners' cognitive levels.	n	0	0	0	2	1	0
27	You include practical in your science teaching program with a view to motivating learners to participate actively.	n	0	0	0	1	2	0
28	I know the best method to teach science.	n	0	0	1	2	0	0
29	I organize co-operative learning for learners	n	0	1	1	0	1	0
30	My lesson plan is in line with my work schedule.	n	0	0	1	1	1	0
31	I motivate learners to complete the many formal activities included as school-based assessment tasks in each term's teaching and learning programme	n	0	0	1	1	1	0
32	I refer to the CAPS senior phase natural science document to check whether I am teaching the correct content.	n	0	0	0	0	3	0
33	Learners' activities are calculated to meet the respective natural science learning outcomes and their associated assessment standards as specific aim in CAPS (2011).	n	0	0	0	2	1	0
34	In-service training sessions are provided by the facilitators to inculcate the conceptual framework considered appropriate for Senior-phase natural science.	n	0	0	0	2	1	0

Document analysis of the assessment recording tool showed deficient compliance in many instances with submission of tasks. Learners were not made aware of the CAPS requirements. Spady, the ‘father’ of OBE, defines authentic assessment as ‘the process of gathering information directly pertinent to the quality of performance that perfectly embodies all the defined aspects of that performance-hence the term ‘authentic’ (1994:189). Question 31 shows that not all teachers motivate learners to complete the many formal activities included as school-based assessment tasks in each term’s teaching and learning programme. The Department of Basic Education’s National Protocol for Assessment of Grades R–12 (January 2012) (Department of Basic Education, 2012b) states that formal assessment (assessment of learning) provides teachers with a systematic procedure to implement towards gauging learners’ progress in a particular subject and grade. CAPS natural sciences Grades 7-9(2011) states that assessment is a continuous and planned process of identifying, gathering, interpreting and diagnosing information about learners’ performance. On being questioned about non-compliance with SBA tasks the subjects responded as follows in the focus group interview:

“School based assessment tasks or formal tasks are increased but the tasks, especially the formal practical tasks should be provided with a practical worksheet like my life science facilitators are providing for learners, senior-phase learners are to be provided Practical work sheets to complete”

“Formal tasks are sent by facilitator without a marking guideline or memorandums every teachers are using their own memos which is not right”

As per the above discussion, teachers have to prepare the formal tasks and their marking guidelines on their own. Teachers failed to set these formal tasks to a good standard as the workload of such tasks, especially practical tasks increased inordinately. CAPS Natural Science Grades 7 – 9 DBE (2011) generated more SBA tasks. Department of Education to review the necessary formal assessments of senior-phase according to CAPS as the current recording tool required excessive assessments (Refer to Appendix J, K, L) that are not easy to complete in a short period of time as it takes lot of teaching time, for instance in term 4. Learners’ responses in completing their SBA tasks are as follows:

“Some learners don’t want to do; some learners wait for other learners to finish to copy from those learners”;

“We don’t have resources to complete our formal tasks; no internet; no textbooks, we must be 18years and older to access to internet at the library;

Each learner from Grade 4 to Grade 12 must have a textbook for each learning area / subject. Jacobs, Vakalisa and Gawe (2004) maintain that a sterling quality of the textbook is its stability, which allows it to be used repeatedly without having to take account of changes, and which therefore allows the learner to proceed at a pace that suits him or her. Question 25 shows that learners are not provided with resources. The importance of resources was reviewed in section 2.9. The researcher noted that learners need resources to complete their school work to improve their performance. Responses to question 26 shows that they use Bloom’s cognitive learning levels to develop learners’ skills in their Natural Science teaching as reviewed in Section 2.8.

Responses to question 27 prove that teachers provide practical activities for learners. Thao Vang (2013) says science knowledge and skills are developed and constructed through hands-on and minds-on activities, not by simply watching and listening, no matter how clever or appealing the technology is which reviewed in section 2.10. The responses to question 29 show that few teachers are not organising cooperative learning in the classroom. As noted by Peters (2011) the teacher provides an environment where learning in the zone of proximal development is maximised. The teacher can arrange a cooperative learning group in which another student will be knowledgeable other. It is a method of moving from lower learning to higher learning. According to CAPS Natural Science Grades 7 – 9 DBE (2011) the teaching and learning of natural sciences involves the development of a range of process skills that may be used in everyday life, in the community and in the workplace. Van der Horst and McDonald (1997) define a teaching strategy as a broad plan of action for teaching activities with a view to achieving an aim. Typical characteristics of such strategies include inquiry, discovery, science process skills and cooperative learning. The latter, as evidenced by responses to question (29) is seldom utilised. As noted by Van der Horst and McDonald (1997), it entails instruction that stimulates peer interaction and learner-to-learner cooperation that enables success all round, first by improving learners’ understanding and skills in the

relevant learning area, and secondly by cultivating learners' group-cooperative skills with due allowance for differences occurring between individuals and cultures that typify learner populations in South African classrooms.

Work schedule

The yearly plan or work schedule would link to the school's or department's overall curriculum map which would derive from Curriculum 2005. The quarterly plan would consist of some aspects of the study programme as laid down according to Curriculum 2005. The district provided an annual teaching plan (Appendix I) in the form of a table which contains only components of the natural science learning areas termed life and living, matter and materials, energy and change and planets and earth beyond. There are no detailed expositions of concepts, contents, suggested activities and time allocation relating to natural sciences.

Teachers use CAPS (2011) and a previous year's work schedule as guidelines to teach natural science content. Responses to question(33) show that teachers refer to the CAPS document relating to senior-phase natural science to check whether they are teaching the correct content. Appendix H shows a sample lesson plan provided by the district. Learners could not cope with exam questions because teachers only taught topics instead of a full range of specific science concepts. Teachers responded to the work schedule as follows:

“Our facilitator gave us annual teaching plan which is not indicating what to teach to what extent we have to teach, on which topic we emphasis more”

“We use CAPS document as guideline to teach”

“We omit some topics as we don't understand; we think that we have done, but it is not true”

Table 4.4 Annual Teaching Plan

TERM	STRAND	TOPIC	TIME IN WKS	Week + Date	% coverage
1	Life and Living	Cells as basic units of life	2	20/01 – 31/01	5.88
		Systems in the Human Body	2	03/02 – 14/02	5.88
		Human Reproduction	2	17/02 – 28/02	5.88
		Circulatory & Respiratory Systems	1½	03/03 – 12/03	4.41 4.41
		Digestive Systems	1½	13/03 – 24/03	4.41

From the discussions above the researcher noted that the teachers are in need of a detailed work schedule for effective teaching and learning. Educators at all levels are key contributors to the transformation of education in South Africa. The National Curriculum Statement envisions teachers who are qualified, competent, dedicated and caring and who will be able to fulfil the various roles outlined in the Norms and Standards for Educators of 2000 (Government Gazette No 20844)

The responses to question 34 show that the Natural Science teachers need training. Van Der Horst and McDonald (1997) continue that planning and preparation for teaching, like curriculum development, occurs at many different levels, planning at classroom level is done by the teacher. The researcher noted through the above discussion and their responses to question 34 that the teachers need subject developmental training. Peters (2011) emphasis professional development sessions provide an opportunity for educators to continue to learn scientific knowledge and skills to strengthen their classroom teaching. The researcher noted that the teachers need training.

Reasons for learners' poor performance

The reasons that related to learners' poor performance were discussed and the responses to question (36) show that natural science classes are large. According to Van der Horst and McDonald (1997) learner participation through cooperative learning will not only lead to more successful learning in class, but will also provide teachers with the means to address the issue of dealing pedagogically with large classes in a South African context.

The teachers' responses relating to reasons for poor performance include the following:

“Since there are fewer practicals, the learners cannot get the true understanding of what we are teaching”

“Due to large classes we cannot provide full attention on an individual”

“There are too many classes and different grades to teach. I have no time to prepare for the topics for different grades”

According to a report published in 2007 overcrowding in South African schools declined in the decade from 1996 to 2006 by 26 per cent from 51 percent (i.e. percentages reflect numbers of schools) (RSA 2008(a):186). A public school must admit learners and meet their educational requirements indiscriminately; consequently overcrowding compromises teachers' ability to meet learners' educational needs, for example because it is difficult to maintain discipline and a homogeneously positive spirit among learners that is attributable to increasing divergence as a result of increasing diversity as numbers rise (Jacobs, Vakalisa & Gawe (2004). Shortages of textbooks are another problem that tends to escalate as classes become overcrowded. Felder gives the following sound advice. A reliable technique is the in-class exercise. As you lecture on a body of material or go through a problem solution, instead of just passing questions to the class as a whole assign a task and give the students anywhere from 30 seconds to five minutes to come up with a response (Felder 1997:1). In large classes lectures need to be stimulating.

The following are examples of learners' reasons for their poor performance:

*“It is due to lack of classroom discipline: some learners are disturbing us
We are also sometimes behave badly in class; so the lesson is getting interrupted”*

“I am sitting in the front of the class; sometimes madam has to go to the back to participate with the bad learners so we are getting disturbed”

“Before we come to this school we were good, after we come here in this school, we inherit the bad attitudes. This is infected to everyone; we are infected to this environment”

“We are lacking of diagram skills. We find difficult to analyse and answer the diagram questions”

Van Deventer and Kruger (2003) say that a school culture where a spirit of collegiality and a unifying desire to achieve are the order of the day will tend to be constructive and productive in that teaching and learning will be the foremost concerns and beneficiaries of its endeavours. Management principles that are conducive to effective classroom practice include initial preparation (i.e. advance planning to eliminate delays, distractions and disruptions), participative planning, and cultivating order (Jacobs, Vakalisa & Gawe, 2004). Disruptions caused by learners and requiring disciplinary action may nevertheless occur. Thus every teacher must develop a repertoire of classroom management skills that combine proper planning with good interpersonal skills. Rule reminders help learners to internalize behavioural control. Teachers should adjust divergent management styles to encourage learners to participate. School discipline is the system of rules, punishments and behavioural strategies appropriate to the regulation of learners and the maintenance of order in schools. Its aim is to create a safe and conducive learning environment in the classroom. Facilities and equipment of an acceptable standard, or preferably better, create a positive environment in which effective teaching and learning can take place. The research site for the study under review is a combined school where the range (Grades R-12) subsumes an intermediate phase, a senior (GET) phase, and a further education phase. Each phase has its own time intervals and breaks. At the research site, however, classrooms are overcrowded and there is a shortage of learning materials (e.g. books) and furniture such as tables and chairs. For example, there are 48 learners in one Grade 8 class where learners have to keep their notebooks on their laps to write.

As regards the learner’s comment about “diagram skills”: According to Jacobs, Vakalisa and Gawe (2004), a diagram is a condensed drawing consisting primarily of lines and symbols forming an illustrative graphic representation of interrelationships, general outlines, or key features of a process, object or area. Most diagrams rely heavily on symbols – a form of

shorthand – to convey information. A factor to consider, thus Van der Horst and McDonald (1997:109), is that learners in Grades 9 and 10 are entering adolescence, which heralds a life stage of rather radical change, for example in gender orientation towards each other, characterised by interaction of gathering intensity. The researcher noted that the factors mentioned above are some of the causes of the learner performance in Natural Science.

The following are examples of teachers' responses relating to teaching strategies:

“Group work, peer learning, self discovery and questions and answers”;

“Presentation, ask learners to research some words and group work methods”;

“Group work, questions and answers methods are used”

The authors emphasise that cooperative learning is not merely another name for group work. Rather, according to the Revised National Curriculum Statement covering Grades R-9(2002),the Natural Sciences Learning Area Statement envisages a teaching and learning milieu that recognises that the people of South Africa have a variety of learning styles as well as culturally influenced perspectives. As noted by Jacobs, Vakalisa and Gawe (2004)the socio-economic environment in which the child grows up has important implications for the child's achievement at school, level of aspiration, motivational level and attitude towards school. Teachers must therefore be well-informed about learners' socio-economic realities so that they can prepare lessons accordingly. Vanderwolf *et al*(2005) states that in practice, as every student knows, one or two students in every group do all the work while others watch. Consequently some (in fact the majority) are left out of the learning equation. During group work strategy, teachers should supervise groups, giving advice and encouragement, and help where needed. Through the discussion of the queries above the researcher noted that the learners need remedial support to improve their natural science performance.

4.3.1.2 Ways to develop learners' scientific knowledge

As noted by Van Der Horst and McDonald (1997), the physical, life and earth sciences involve the systematic study of the material universe – including natural and human made

environments – as a set of related systems. A variety of methods that have the collection, analysis and critical evaluation of data in common are used to develop scientific knowledge. Natural-science teachers responded as follows in selected instances when asked for advice on developing learners’ scientific knowledge:

“The main problem is learners’ science vocabulary: to address and improve this is by giving terminology activities and rapid fire questions to answer before we introduce a lesson”

“We should have a word wall; ask learners to research science words.”

“Learners lack practical and syllabus lack practical too.”

Best, Dockerel, and Braisby (2006) emphasise that teachers’ nonverbal gestures or graphic representations explain science concepts in ways that all learners can understand regardless of cultural and linguistic diversity. Wellington and Osborne (2001) assert the following: “Learning to use the language of science is fundamental to learning science.” When teachers and students share science vocabulary they learn to communicate while doing science. Definitional information should be taught: When reading definitions with learners must make sure that they understand how to read pronunciation keys, parts of speech etc. Improving the quality of school science laboratories is a key aspect of the *Building Schools for the Future* initiative (HM Government, 2008). Best, Dockerel and Braisby (2006) emphasise that teachers’ use of nonverbal gestures or graphic representations convey the substance of science concepts and are beneficial for all learners, including those from culturally and linguistically diverse backgrounds. Many teachers use word walls to provide visual clues to words introduced in class. It is also important for teachers and students to *use* the words as much as possible. Students can look at the written words as teachers use them during class discussions, and teachers should encourage students to use the language of science in their verbal and written communication.

To develop scientific literacy learners need to know science content. In the science class teachers teach content due to time constraints and forget to teach science vocabulary to assist learners’ understanding of text. According to Best, Dockerell and Braisby (2006) vocabulary instruction is effective when it includes visual, verbal, and physical support; therefore physical scaffolding is critical in content-area teaching. Teachers’ use of nonverbal gestures

or graphic representations explains science concepts for the benefit of all learners despite cultural and linguistic diversity. Modelling the use of vocabulary throughout instruction not only reinforces students' comprehension, but maximises the efficacy of teachers' instruction time. The researcher noted that the factors mentioned above are some of the remedies that can improve learners' scientific knowledge.

The following are selected responses elicited from learners concerning advice on how to improve their performance:

"I do understand science concepts but I am not studying at home and ask my parents to help me if I need more help";

"Sometimes some learners understand the subject better; so better understanding friends can help other learners through group study; this group study can take place after school";

"Science vocabulary and terminology tests can improve our performance";

The following advice was received from teachers on introducing science concepts in class:

"By showing a matching sample to the concept; it depends upon the concept"

Herrera and Riggs (2013) identify students' conceptions about four core concepts in sequence stratigraphy: base level, global sea level, accommodation, and relative sea level. We placed students' answers to these topics in a continuum of conceptual understanding that stretches from unarticulated alternative conceptions to fully elaborated scientific conceptions. The current study builds on that analysis and expands on it by surveying students' use of mental schemas that operates in the generation of such conceptions. Trefil, and O'Brien-Trefil, (2009) suggest that science concepts should be introduced to senior-phase learners in an appropriate way, for example by means of practical demonstrations that can be linked to the real world. Science educators must generate connections between science concepts, societal issues, and the vocabulary students will meet in textbooks. Wellington and Osborne (2001) note the following: "Learning to use the language of science is fundamental to learning science." When teachers and students share science vocabulary they learn to communicate while doing science. Woolfolk (2010) insists the two central features of teaching conceptual

changes in science are: teachers are committed to teaching for learner understanding rather than ‘covering curriculum’, and learners are encouraged to make sense of science using their content ideas. Teachers should teach a science concept with scientific models to make the learners understand the concept.

Jacobs, Vakalisa and Gawe (2004) point out that parents are expected to familiarise themselves with the new curriculum so that they can assist their children with schoolwork. Engaging parents in the education of their children at home is increasingly viewed as an important aid to an endeavour to improve children’s outcomes. Parents can contribute support for their children and stimulate their interest in learning at home according to self-imposed goals. One of the goals set by Curriculum 2005 for South Africa and outcomes-based education is the integration of all learning areas. This injunction presents a daunting challenge that calls for a team approach that should involve every staff member, parent and learner, as well as the community.

4.3.1.3 Learners gain a better understanding of science concepts and principles by applying theory to practical situations.

The CAPS senior-phase programme for Grades 7-9 DBE (2011) states that every learner should have access to sufficient workspace and equipment to carry out investigations. This objective is unachievable at the relevant school where the research is to be carried out as it is a public school where classrooms are in short supply, as are equipment and chemicals. In the focus group interview the following are some of the responses elicited from teachers about the matter of applying theory to practical situations:

“All learners should participate in the practical test and they have to conduct themselves like FET and write report and draw”

“There should be more hands-on-activities in science teaching; teachers can demonstrate; at least show the chemicals to the learners to see the colour and the texture of the chemicals”.

“There is lack of science equipments and chemicals so I can’t be able to do any practical for my learners”.

Vanderwolf *et al.* (2005) maintains that natural science is fundamentally an attempt to achieve a rational understanding of natural phenomena. Students should therefore be encouraged to study nature itself rather than only books or computer simulations. Although student laboratories or teacher-performed demonstrations are essential to science teaching, a competent teacher should always lead and direct the activity. Experienced scientists believe that undergraduates require extensive instruction before being allowed to do independent research. Gillis (April 9, 2013) emphasises the need for competent teaching of the scientific process to ensure that students understand scientific methods and will be able to evaluate scientific evidence critically. Millar (2004, p2) contends that practical work subsists in ' *any teaching and learning activity which at some point involves the students in observing or manipulating the objects and materials they are studying*'. So science experiments and demonstrations can make learners' better understanding of science concepts. Teachers should bear in mind (cf. NCS (2012) CAPS Orientation) that the NCS Subject Statements spell out broad content for each of the subjects, as well as what skills are to be developed and what is to be achieved by the end of each grade. CAPS spells out specific content (topics and sub-topics), as well as what the expected outcomes are annually, per term and even daily in some cases. OBE is an outcomes-based approach to the delivery of curriculum. As the research site is a public (i.e. no-fee) school its population is self-evidently drawn from informal settlements, which implies that teachers have to resort to specially adapted teaching methodologies to instill the relevant concepts in their minds. Teachers do try to improve teaching and learning despite the deficient physical environment and facilities and equipment. Teachers' responses to the issue of how frequent practicals should be presented are exemplified by the following:

"Depend upon the syllabus; as indicated in the CAPS document".

"We have to organise practical everyday".

"Always we concentrating on the content coverage; we are focus on the syllabus coverage so we ignore the practical";

The responses to question (58) show that learners participate actively in the practicals.

Responses are exemplified by the following:

"We are interested in science practical especially investigating the effect of exercise on pulse rate".

Rousseau (1911) proposed that children should not be taught directly but should be allowed to discover things for themselves, especially through play, and that learning how to learn was of much greater importance than teaching factual information. Through the discussion above the researcher noted that learners need various strategies of learning for example more practicals so that they see and get a better understanding of the science concept that has been taught. The researcher also noted that the teachers need science material for the experiments to be conducted to improve the learners' understanding.

4.3.1.4 Factors attending teaching and learning in the classroom

The focus group interview revealed that natural-science teachers are specialised in particular subjects. One teacher is specialized in physical science, another in life science, and yet another in general science.

The educators were indicated the factor (if any) that exerts the most profound influence on their science teaching by marking the most appropriate response with a cross X

The responses to questions 35 to 44 show that the classroom environment is not conducive to teaching and learning. In such classes the teacher uses a different strategy to make learners participates actively. During the focus group interview and the responses to question 35, it is obvious that there insufficient resources. Prain and Tytler (2012) say we know from research that teachers and students use the full range of material resources, actions, gestures and technologies available to them to construct and express meaning in science.

Table 4.4 Educators' responses in terms of Natural Science classroom climate

35	Not enough resources for learners	YES	NO
		3	
36	Large classes	YES	NO
		3	
37	Too many formal tasks per term	YES	NO
		3	
38	Incomplete formal tasks	YES	NO

		1	2
39	Documents are in place	YES	NO
		3	
40	Classroom is conducive for teaching and learning	YES	NO
		1	2
41	Enough charts and models in the classroom	YES	NO
		1	2
42	Qualified and experienced to teach natural science	YES	NO
		3	
43	Lesson preparation contains learners' activities and assessments.	YES	NO
		3	
44	Subject facilitator provides support.	YES	NO
		1	2

The following responses reflecting difficulties around natural-science teaching are presented below for illustrative purposes:

“Lack of learning resources such as text books, practical materials”

“Some topics are abstract; very difficult to teach”

“I don't have any background of physical science but I have to teach I can't understand chemistry topics how can I teach those topics to learners, but still I am teaching natural science at least our facilitator give us workshop regularly before start of a new term for upcoming topics we need a workshop from district”

The new curriculum is adapted to suit the roles spelled out for teachers in the Norms and Standards for Educators (2000) (Government Gazette No 20844). A person is critically literate in science, meaning she has the ability to read, write, think, and talk about real-world science issues (Lapp & Fisher, 2010). Science educators must generate connections between science concepts, societal issues, and the vocabulary students will meet in textbooks. One of

the best ways for teachers to help students to comprehend a science text is to model the thinking that occurs while reading graphs, charts, data tables, and data analysis sections (Taber,2011).

ICSU (2011) states, unfortunately, in most countries around the globe, teacher preparation in science and mathematics is woefully inadequate. There is an urgent need for better training of teachers at all levels so that learners will be informed both accurately and inspirationally, thereby firing up their imaginations and fostering curious and analytical minds. Following that ICSU (2011), states an educational institution's most important asset is its teaching staff. Teachers' pedagogical and subject knowledge is critical for effective teaching. Learning and teaching are inseparable.

Lunneta *et al* (2007) define teaching as 'learning experiences in which students interact with materials or with secondary sources of data to observe and understand the natural world. The authors consider this a classical definition. According to Pierre Du Plessis *et al.* (2007) teaching and learning are closely interdependent, and besides helping learners to learn, teaching can be seen as a critical means of creating opportunities.

Trefil and O'Brien-Trefil(2009) take the view that critical issues affecting the material well-being in the immediate sense, as well as the future of mankind, should be given pride of place in the development of young people's scientific literacy and related social responsibility.

The following are examples of reasons given by learners to explain difficulties they had with science learning

"We are taking natural science subject for granted not taking it serious";

"Some topics are difficult; we can't even pronounce them;

"Some teachers are not teaching natural science; they are busy with their cell phones";

"Because of our bad attitude sometimes teachers ignore us".

Learners' difficulties with critical thinking and problem solving will not be resolved unless they come to terms with the hard work and rigorous discipline required to gain a worthwhile education. Incompletion of lesson plan has proved that there is lack of teaching content happened in the research site. If learners believe that failing means they are stupid they are likely to adopt self-handicapping and self-defeating, strategies. And teachers who stress

performance, grades, and competition can encourage self-handicapping without realizing they are doing so (Anderman&Anderman, 2009)..

Responses to question 55 shows that classrooms are not conducive to natural-science learning, and responses to question 41 report insufficient charts in the classroom. In the South African context standardised layouts to cater for teaching requirements are virtually non-existent. Cramped conditions, noisy locations, windowless rooms, and outdated or a dearth of equipment or none at all, are not uncommon. Learners' responses in this regard include the following

“We don't have a science lab to carry out hand-on-activities; we are using a prefab to learn natural science and it is very hot; it is not conducive for teaching and learning”;

Bloom(1976:111) aptly notes that:

..... it is the teaching and not the teacher that is central, and it is the environment for learning in the classroom rather than the physical characteristics of the class and classroom that is important for school learning.

Since it is a public combined school due to the shortage of classrooms teachers use different classes to teach. A newspaper article (cf. 'Sowetan', 13 August 2013) reported that at Moses Minisi high school, Mpumalanga, 'learners are learning in the rain as the school barely has a roof and no electricity. Damaged floors pose a danger to both teachers and pupils at this school. A pupil has to sit on a tree stump instead of a proper chair. Children are sent home because we cannot risk their lives'. Soobrayan, BEDG, quoted in 'Sowetan' (4February 2010) observed that South Africa 'faces a crisis in basic education' as evidenced, for example, by the dropout rate between Grade 9 and Grade 12. Educators at all levels are key contributors to the transformation of education in South Africa. Teachers have a particularly important role to play. The National Curriculum Statement envisions teachers who, at the end of their training, are duly (i.e. professionally according to best-practice standards) qualified, competent, dedicated and caring and who will be

able to fulfill the various roles outlined in the Norms and Standards for Educators of 2000 (Government Gazette No20844).

4.3.1.5 Science teachers promote learners' scientific literacy

Holbrook and Rannikmae, (2007) say that a new definition is put forward for scientific literacy and hence the target for science education. This tries takes note of the need to address an appreciation of the nature of science and the relevance of the science being acquired.

The following responses are indicative of teachers' rating of learners' science literacy:

“We can conduct science aptitude test with science vocabulary questions and find out learners' performance”

“Like district conducted in 2013 to investigate natural science learners perform better physical science and life science like that organise for grade 9 learners to their performance”

As Trefil and O'Brien-Trefil (2009) noted, questions should provide the foundation of young people's scientific literacy and related social responsibility. A key part of being critically literate is involvement, ultimately, in issues beyond the personal. Teachers can help students become part of society's science conversations by using real-world applications of science in instruction and by inviting students to discuss and debate relevant and motivating content.

Through the discussion of the queries above the researcher noted that science teachers can organise various science programs to improve the learners' interest in learning science.

In 2013, the natural-science test results of Grade 8 learners at the school serving as the study site showed, as indicated for senior-phase learners (see above), that learners were performing better in physical science than in life science. Such programmes provide students with a foundation in science that creates opportunities for them to pursue progressively higher levels of study, prepares them for science-related occupations, and engages them in science-related hobbies that suit their interests and abilities. The following are examples of reasons given by learners for performing better at physical science than at life science

“In understanding concepts chemistry is more interesting than life and living as we are learning about the chemicals that we use at home”.

Stepans (1994) Students’ ideas do not always evolve as quickly as the rate of concept presentation in most textbooks as well as in many teacher-designed units of instruction.

Learners completed a questionnaire by writing to show their background and their interest in learning science.

Table 4.5 Learners’ responses of their background details

45	Age	Less than 15	More than 15							
	Responses	7	1							
46	Gender	Male	Female							
	Responses	4	4							
47	Ethnicity	Black	White	Coloured	Indian	Other				
	Responses	6		1	1					
48	Your highest achievement level in science as noted in your progress report	L1 80-100	L2 70-79	L3 60-69	L4 50-59	L5 40-49	L6 30-39	L7 0-29		
	Responses		2	1	2	1			2	
49	The mode of transport you use to travel to school	Car	Public transport	Walk	Other					
	Responses	6	2							
50	Your home language	Afrikaans	English	Isizulu	Setswana	Tsepedi	Sot ho	X ho sa		
	Responses		2	3			2	1		
51	Subject choices in FET phase	Physical science	Life science	Both	others					
	Responses	1	1	6						
52	Type of school you are attending	Public school	Private school	Other						
	Responses	8								
53	Language of teaching and learning.	Afrikaans	English	Isizulu	Other					
	Responses		8							
54	Your province	G	KZN	M	N W	L	FS	WC	EC	NC
	Responses	8								

The researcher invited ten Grade 9 learners. Two of them apologised for their absence. The responses to questions 45 -54 show that there were 4 boys and 4 girls who participated in the

focus group conducted after school hours. Seven learners belong to age group of less than 15 and one learner is more than 15. The participated learners 6 of them are blacks, 1 coloured and 1 Indian. Besides two learners the other learners achieved good marks. English is home language for two learners and rest of the learners use different African languages. Their language of teaching and learning is English. They are all attending the public school and are from Gauteng province. In the FET phase they all would like to choose science subjects (question 51) as their career choice. A key requirement of Curriculum 2005 is that learning within an area and between areas should be integrated (e.g. integration of life, earth and physical science under natural sciences)

Table 4.6 Learners conceptions in the learning Natural Science

55	Classroom is conducive for learning	Yes	No					
	Responses	6	2					
56	Interest in learning science	Yes	No					
	Responses	8						
57	Remedial support from teacher	Yes	No					
	Responses	5	3					
58	Actively participate in practical	Yes	No					
	Responses	7	1					
59	Aware of CAPS 2012	Yes	No					
	Responses	5	3					

Responses to question (58) show that learners are interested in science. Learners should show interest in science-related questions and issues, and pursue personal interests and career possibilities within science-related fields. Responses to question (55) indicate that the classroom is not conducive to learning and teaching Natural Science. Responses to question 57 show that three of the learners were not provided with remedial support. Abrahams and Millar (2008, forthcoming) argue that ‘teachers need to devote more lesson time to helping students use ideas associated with the phenomena they have produced, rather than seeing the successful production of the phenomenon as an end in itself.’ Responses to question 58 show that most of the learners actively participate in practical. Responses to question 59 shows that most of the learners not aware of the requirements of CAPS (2011) Pointed questions raised in this regard in the focus group interview elicited responses such as the following:

“I am going to take all science subjects”;
“I am going to take physical science, Life science and Geography”;
“I am going to take science subjects and Economics”;

Jacobs, Vakalisa and Gawe (2004) attribute the popularity of science and technology as indicated to the dire shortage of learners who gain the necessary qualifications to follow careers in these two fields, and even if they do, a career choice in that direction does not necessarily follow matriculation. It is therefore of crucial importance that teachers persuade more learners to follow careers in science and technology. The following are examples of learners’ responses concerning their career preferences/aspirations.

“I would like to go to University to study to become a Pilot”;
“I would like to become an astronaut”;
“I would like to go to London to study to become a Cardiologist”;

Developmental outcome 4 as contained in the context of the South African Qualifications Authority Act of 1995 encourages exploration of education and career opportunities. The issue addressed in this outcome is the lack of career guidance, as well as ignorance among learners about opportunities for further education. There is a clear need for every teacher to help learners focus their attention on their own goals, interests and talents, and to do extensive career exploration while they are still at school. To help students reach teachers’ aims and expectations, teachers must understand how learners actively construct new knowledge, as well as the complexity of the learning process, the importance of students’ interests, and the potential anxieties and conflicts occasioned in students’ minds by their exposure to science concepts. Through the above question discussion the researcher noted that the learners need to be provided a comprehensive careers education and counselling service.

4.4 SUMMARY

According to Learner Career Guidance in the Education, Training and Development sector: Grades 9 to 12 ETDP-SETA, Department of Higher Education and Training, a material factor to be borne in mind when teaching senior-phase learners is that they can be emotional and

unruly as they enter the teenage years, which means that teachers need to treat them with tactful circumspection and understanding. Furthermore: teaching occupations considered scarce skills in the intermediate and senior phase(Grades 4 to 9) are Mathematics teachers, Natural science teachers, Economics and Management Sciences teachers, Life Skills teachers. In chapter 4 the factors that related to learners' poor science performance were discussed.

The importance of scientific literacy in science education and the ways to develop learners' scientific knowledge was explained. The role of practicals in improving learners' conceptual understanding is vital and was mentioned. Teachers' challenges in teaching natural science were mentioned. The learners experience in learning natural science and the reasons for their poor performance were analysed. The teachers' perspective towards CAPS document was discussed. In chapter 5 recommendations and conclusion are prepared to improve senior-phase learners' natural science performance.

CHAPTER 5

FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

This chapter presents an overview of the findings emanating from the study under review and ties the findings to the contents of the literature review presented in chapter two to determine whether the findings relate, and provide answers to the research questions to an extent that justifies the purpose of the study. Focus group interviews were conducted with learners and teachers to establish how to develop learners' scientific knowledge, the effects of applying theory to practical situations, the various teaching strategies employed to teach science concepts, the documents used as reference material to prepare lessons, the factors that relate to and possibly explain senior-phase science learners' poor performance in science, the strategies employed to introduce science concepts to learners, the difficulties that teachers and learners experience in teaching and learning natural science, and the science discipline teachers are expected to teach in virtue of their specialised training to that end. Prof Elize du Plessis (2013) notes that although OBE is de-emphasised in the new CAPS policy, it is still relevant and we are in the process of revising existing study material. The debate about CAPS mainly takes its cue from the question whether it is an amendment, a repackaging, or even a re-curriculation. CAPS was implemented in January 2014 for the Senior Phase (Grades 7–9) and Grade 12 (FET). Before that date (i.e. in 2013) all senior-phase teachers of natural science were trained by the district.

Du Plessis *et al.* (2007) suggests that a variety of teaching strategies be used, such as direct instruction, discussion, learning in the context of small groups, cooperative learning, problem solving, simulation, role-playing, case studies, brainstorming, and research into OBE. Recommendations based on the findings resulting from the study under review are made with a view to benefiting from strategies implemented by teachers to improve senior-phase learners' conceptual understanding of science, their scientific literacy, their command of science language, and their capacity for practical integration.

5.2 RESEARCH QUESTIONS

The questions generated from the problem statement are as follows:

What are the factors related to learner performance in Natural Science?

- What are Grade 9 learners' view/perceptions about their performance in Natural Science?
- What are learners' conceptions (i.e. understanding and usage of scientific concepts) in the learning of Natural Science?
- How do teachers teach selected concepts on scientific literacy?

5.3 AIM OF THE STUDY

The aim of this study is to explore factors related to learner performance in Natural science at the school concerned, and to propose remedial measures to improve such performance.

Primary objectives of the study are as follows:

- Identify Grade 9 learners' views/perceptions about their performance in Natural Science
- Identify learners' conceptions (i.e. understanding and usage of scientific concepts) in the learning of Natural Science.
- Explore ways teachers teach selected concepts on scientific literacy.

5.3 RESEARCH METHODOLOGY AND DESIGN

This study was predicated on a qualitative, non-experimental, exploratory and descriptive approach entailing interviews and questionnaires for information gathering. This approach was considered well-suited to capturing educators' and learners' authentic views in order to shed useful light on the process and setting of science teaching and learning. The focus group interview revealed that teachers need assistance to familiarise them with science topics as seen from a pedagogical perspective. District support should provide continuous classroom support, workshops for the training of teachers on curriculum matters, mentoring and coaching and guidance in the interpretation and implementation of curriculum policies at

classroom level. Discussion entails a cooperative learning strategy that subsists in learners working in concert to ensure that they achieve the same learning. Such learning is highly prized by Johnson and Johnson (1992:218) who assert that “without cooperation among individuals, no group, no family, no organisation and no school would be able to exist”. In a later publication the same authors assert that cooperative learning gives learners the emotional and academic buoyancy to prevail against the many obstacles they face at school.

5.5 SUMMARY OF FINDINGS

As senior-phase learners have been underperforming at natural-science subjects for many years, the purpose of the study under review was to identify the causal factors and propose remedies. Therefore focus group interviews were conducted with teachers and learners separately. The following findings were included.

5.5.1 Findings relating to learner performance in Natural Science

The focus group interview with teachers suggests the following factors related to learners’ poor science performance

- Large classes
- Lack of interest in creating lesson plan.
- Inadequate support from subject facilitator
- Lack of teacher development training
- No detailed annual teaching plan for effective teaching and learning
- Inappropriate subject allocation for teachers
- Lack of laboratory materials to carry out experiments for better conceptual understanding
- Excessive formal tasks take up teaching time
- Science process skills not presented in science teaching
- Various teaching strategies were not used in the classroom
- Lack of quality science programs
- Poor understanding of abstract topics
- Lack of parents’ support
- Language of teaching and learning in second language

5.5.2 Findings relating to Grade 9 learners perceptions about their Performance in Natural Science

Learners lacked the necessary command of science conceptual understanding and academic language acquisition. Learning materials were in short supply, as were furniture and laboratory materials and equipment. Improved school and classroom discipline, as well as organisational culture, was required to achieve better learning. Learners need parents' involvement to perform better. Learners take natural science for granted. There is a lack of provision of career guidance programs for learners. The required assessment of CAPS has been increased (Projects and assignments) therefore learners need access to resources such as the internet and the library.

5.5.3 Findings relating to strategies to advance learners' language in science education

There were not enough intervention and remedial support, with the result that learners did not know the relevant topics, could not pronounce words describing scientific concepts, and were at sea with subject matter generally. The learners need support of academic language learning as they navigate new terms, phrases, symbols, and patterns of discourse while working to gain proficiency in the content area.

5.5.4 Findings relating to accentuating practical work to promote learners' motivation

The outcome of the focus group interview revealed that there were few practicals were carried out in science teaching due to the insufficient laboratory materials. Therefore the learners had a poor conceptual understanding. There are no quality science programs or science fairs to motivate the learners and make it more exciting and lively.

5.5.5 Findings relating to the role of science educators in teaching scientific literacy.

There are insufficient graphical and visual representations in the classrooms. Few drawings, diagrams, and pictures were used to support the spoken word. Natural-science teachers found it difficult to teach physical science because they were only qualified to teach life sciences. The attitudes and values developed toward science in the school will improve learners' scientific literacy however it was not successfully achieved. Some teachers' workload (large classes and several grades) prevents effective planning. Although teachers are relieved with less administration with CAPS, it does not suggest that teachers should not prepare the lessons.

5.5.6 Findings relating to CAPS, Natural science 2011

Although they were trained according to CAPS the principles were not followed, but they were not familiar with the CAPS specific aims in any case. The new topic should be taught to the learners based on their prior knowledge, but CAPS for Grade 9 introduces new and abstract topics to the learners and the teachers.

5.6 RECOMMENDATIONS

Results from the findings and conclusions of this study some recommendations for improving senior-phase learners' natural science performance are now presented.

5.6.1 Recommendations relating to conceptual understanding of science

Graphic organisers and visual representations can help to present words with a range of contextual information (see chapter 2.4). Teachers can use word walls to provide visual clues to words introduced in class. Instructions should be given using a variety of visual or aural support materials: drawings, diagrams, and pictures to support the spoken word. Science educators must generate connections among science concepts, societal issues, and the vocabulary students will meet in textbooks. All science topics should be connected to real-world applications and instruction explicitly to learners' personal experiences.

5.6.2 Recommendations relating to scientific literacy

Scientific literacy is considered to be a key outcome of education for all students by the end of schooling not just for future scientists given the growing centrality of science and technology in modern societies. Teachers can help students become part of society's science conversations by using real-world applications of science in instruction and by inviting students to discuss and debate relevant and motivating content. Scientific inquiry refers to the methods and activities that lead to the development of scientific knowledge (Schwartz et al., 2008). Science literacy is important in learning Natural science so teachers encourage it through inquiry instruction which promotes the understanding of science concepts as and science literacy (see chapter 2.5).

5.6.3 Recommendations relating to the role of teachers

Intermediate and senior-phase teachers are responsible for school learning during a very important phase in the child's life. Teachers guide classroom discourses with different kinds of pedagogical intervention. Carl (2010) notes that the teacher plays an important role in the classroom, particularly in regard to the planning of lessons and lesson units, and therefore needs to be adept at identifying appropriate teaching methods and objectives, analyse content, plan learning experiences and opportunities, consider teaching methods, sequence constructive learning events and evaluate their effect to best advantage. Teachers are encouraged to fill in their lesson plans for effective and efficient teaching with a view to achieving the desired outcome(see chapter 2.8). In large classes, learners should sit near each

other to gather collective benefit from the teacher's attention with the least possible disruption; moreover the teacher should patrol the classroom to supervise groups, giving advice and encouragement, and help where needed. Group discussions should be used to stimulate students' awareness of other students' thoughts about particular concepts. Teachers should help learners by every means to realise that their capacity for learning is inherently sound and that their efforts, strategies, and persistence are prerequisites for successful learning (see chapter 2.8).

5.6.4 Recommendations relating to teachers' professional development

Teacher education programs need to make a concerted effort to help teachers improve their ability to explicitly translate their understanding of the nature of science into their teaching practices. Furthermore, teachers should be encouraged to view an understanding of the nature of science as an important pedagogical objective in its own right. Therefore, continuous high-quality professional development of teachers is essential for good educational outcomes. Programmes for the effective professional development of teachers typically include deepening and broadening of knowledge of science content, modelling the teaching of new content, as well as best teaching practices enabling teachers to draw their students into, and facilitate their endeavours in pursuit of, scientific investigations. Adequate support from subject facilitator is needed for the natural science teachers. The school policy is designed to influence and determine all major decisions and actions, and all activities take place within the parameters set by the school (see chapter 2.8 and chapter 4.3.1.1).

5.6.5 Recommendation relating to improve learners' performance

Natural science teachers should continually run programmes to improve senior-phase learners' skills, knowledge and attitudes in preparation for further education and careers. Instructions should be given using a variety of visual support materials: drawings, diagrams, and pictures to support the spoken word. Textbooks are a source of information that denotes the truth and provides all the relevant knowledge. Teachers know learners will experience a lack of access to resources, try to find creative ways of overcoming this lack of access (see chapter 2.11). Lack of access does not mean that teachers should never attempt something

simply because of a lack of resources. Teachers repeat words to the learners in their teaching. Science fairs need to be organised to motivate learners to undertake science experiments and thus spark a desire in them to extend their acquaintance with the realm of science.

5.6.6 Recommendations relating to language in science education

Teachers should guide learners to collect and analyse data. Learners may not find confrontation with scientific definitions and formulas (many being abstract) helpful without explanatory preamble unless they have already been sufficiently exposed to the ideas concerned. Science teachers incorporate literacy strategies into lessons, and provide opportunities for students to exercise their academic language fluency through listening, reading, writing, and speaking. As students use science-specific academic language in different activities fluency will increase as they move toward being scientifically literate. Scientific knowledge is naturally built up from basic to more complex elements, which means that basic concepts have to be understood before more advanced topics can be attempted. Within the general approach, teachers have to adapt their instruction to the needs and abilities of their learners- they have to differentiate instruction. Learners need a library with and internet an access to improve their science knowledge (see chapter 2.7).

5.6.7 Recommendations relating to practical work

The importance of practical work in school science is widely accepted but it is important to make sure that such practical work genuinely supports learning and teaching, and that the teacher is allowed the flexibility to initiate and maintain practical work programmes to meet learners' needs, to which end such programmes should slot in effectively with the topics they are learning (see chapter 2.10). To encourage learners' active participation in the lesson, efforts must be made to make the phenomenon real, maintain interest and promote logical thinking practical is important in science teaching. CAPS Natural Science Grades 7 – 9, lists 15 very specific process skills that learners must master in the senior phase. Science laboratory materials are needed for the learners to carry out practicals (see chapter 2.10).

5.6.8 Recommendations relating to CAPS

As noted by the Department of Basic Education (Pinnock, 2011), CAPS is not a new curriculum but an amendment to the National Curriculum Statement (NCS). The new presentation of the curriculum accentuates content rather than outcomes. This means that it is more inclined towards traditional teacher-led rather than OBE methods. CAPS Natural Science Grades 7 – 9 (2011) focuses on the learner taking individual responsibility for learning and the emphasis on critical thinking about knowledge validity and bias (see chapter 2.2).

5.6.10 Recommendations relating to further research

From the present study, various areas requiring further research have come into view. Further research should complement this study by including qualitative data gathering methods such as observation, and field observations and supplementary techniques. These would be important to establish teachers' understanding of important concepts such as scientific literacy and conceptual understanding. Observations in the classroom settings would provide information regarding the actual depiction of natural science education in senior-phase classrooms.

5.7 CONCLUSION

The purpose of the study was to explore the factors that related to the poor natural science performance of senior-phase learners and propose remedies to improve such performance. As a result of the focus group interviews, analysis of documents and the questionnaire, the researcher attained findings. The findings include lack of interesting science programs, lack of teachers' professional development, inadequate support from the subject facilitator, inappropriate subject allocations for teachers, incompleteness of required school based assessments, unavailability of laboratory equipments, poor classroom discipline, non-organizational structure, a lack of career guidance, shortage of resources, poor conceptual understanding, poor planning and preparation of teaching methods, insufficient graphic organizers and visual representations for active participation in learning led to the learners' poor natural science performance. The findings of this study refer to a school situation where teaching and learning take place to optimal effect (i.e. are not significantly at fault) as attested by performance levels. Curriculum development of necessity implicates the teacher's role, which is not only to instruct, but also to facilitate cooperative learning in particular. In-service training can enhance teachers' competence, with particular reference to application skills. The teacher should lead and support the learner towards becoming an independent, balanced

adult who will function effectively in the service of the community, and as a responsible citizen. In the most recent published review of literature on learning and teaching in the school-science laboratory the point is made that natural-science teachers and learners should be familiar with the specific aims indicated in CAPS Natural Science Grades 7 – 9 DBE (2011). They are doing science, they know the subject content, make connections, and understand the uses of Science. Teachers keep these aims in minds when they prepare lessons for effective teaching and learning to produce good results.

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APPENDIX A

Ethics Permission Letter

JSR Anthony

No 26 Olifant Street
Brackendowns
1448

25/08/2014

The School Principal

Palmridge Combined School

Dear Sir

REQUEST FOR AUTHORIZATION TO CONDUCT A RESEARCH STUDY

I am Jasmin Anthony a registered Masters' student at the University of South Africa (UNISA), hereby apply to grant permission to conduct a research study in your School. A research study is a requirement to complete and obtain my Masters' Degree. The topic of my intended study is:

Exploring factors related to learner performance in Natural Science: A case of a school in the Gauteng Province.

The purpose of this study is to identify the factors to which Grade 9 learners attribute their poor performance in science and to propose remedial measures to improve such poor performance.

Natural Science teachers and Grade 9 learners will be asked to volunteer to participate in the study, and they will be allowed to withdraw at any stage of the study without any consequences for them. I will be conducting the study on 23 and 24 October 2014. All data will be kept confidential and no information will be linked to this school or Natural Science teacher. The school and natural science teachers who will participate in this study will be allowed to have access to the final report.

Permission to conduct this study will also be obtained from the Higher Degrees Committee of the Department of Education at UNISA in order to ensure that this study will be conducted in an ethical manner.

Yours Faithfully

Researcher: Jasmin Anthony

Supervisor: Dr P.J Heeralal

(EDUCATOR AND STUDENT AT UNISA REGISTERED
FOR A MASTERS DEGREE IN NS EDUCATION)

012 429 2318

[Tel: 011 868 3002](tel:0118683002) cell: 0763933039

heerapj@unisa.ac.za

E-mail address: jasmin.anthony32@gmail.com

APPENDIX B

Request permission to Participate in a Research

Topic: Factors related to poor natural science performance of senior-phase learners: case study at a school in Gauteng.

25/08/2014

Dear Natural Science teacher

I am undertaking a study to determine the factors related to poor natural science performance of senior-phase learners at your School and to propose remedial measures to improve such poor performance. As part of my research project on the Natural science learning area, I have developed a focus group interview and a questionnaire to determine the challenges in science teaching and conceptual understanding of science concepts. For this purpose, I kindly request that you complete the following questionnaire. The questionnaire should not take up your teaching time. Although your response is of utmost importance for my study towards a Masters degree in NS education, your participation in this study is entirely voluntary. Your participation is, therefore, of most importance to the study and I would appreciate it if you could spare some time to participate in this study. Participation in this study is voluntary and involves no feasible risks or harm. The focus group consists of three natural science teachers and will take about an hour and a half to complete.

Please do not enter your name or contact details on the questionnaire as it has to remain anonymous. I would like to reassure you that the information provided by you will remain confidential and will be reported in summary format only.

The study and its procedures have been approved by the Higher Degrees Committee of the Department of Education in the University of South Africa (UNISA). We foresee no risks if you decide to participate in this study.

Kindly return the completed questionnaire to me on 24 October 2014. Should you have any queries or comments regarding the study, you are welcome to contact me telephonically or through the e-mail address.

Best regards,

Jasmin Anthony (0763933039)

Supervisor: Dr. P. J. Heeralal(012 429 2318)

email address: jasmin.anthony32@gmail.com

heerapj@unisa.ac.za

(EDUCATOR AND STUDENT AT UNISA REGISTERED

FOR A MASTERS DEGREE IN NS EDUCATION)

.....

I..... willingly agree to participate in the study, which has been explained to me in writing by JSR Anthony.

.....

.....

PARTICIPANT'S SIGNATURE

DATE

APPENDIX C

Consent to Parents in a Research

26, Olifant Street

Brackendowns

25/08/2014

Enquiries: jasmin.anthony32@gmail.com

Dear parent,

RE: Permission to allow learners to participate in the research study

My name is Mrs. Jasmin Anthony, a teacher at your child's school. I am currently doing Masters in Natural science Education at UNISA. An investigation of the factors related to poor natural science performance of senior-phase learners and to propose remedial measures to improve such poor performance. As part of my research project on the Natural science learning area, I have developed a focus group interview and a questionnaire to determine the challenges in science teaching and learning and conceptual understanding of science concepts. Participation in this study is voluntary and involves no feasible risks or harm. Five learners with test scores of 50% and higher, and five with scores below 50% were selected. I would really appreciate your help with this study by allowing your son/daughter to participate in the focus group interview, along with nine other learners, and to complete a questionnaire which will be approximately an hour and a half long. I will be conducting the study on 23 October 2014. Your child can decline to participate without penalty, even if you agree to allow participation. The results of the study will be reported anonymously, and kept confidential. No-one will be named in the report.

If you could allow your son or daughter to take part in this study, I would be very grateful. Please sign the attached form and return it to school. If you would like to know more about the study, please contact me telephonically at 0763933039 or through the email address.

Many thanks for taking time to read this letter and for your help.

Yours sincerely,

Jasmin Anthony.

Supervisor: Dr. P. J. Heeralal

(EDUCATOR AND STUDENT AT UNISA REGISTERED

012 429 2318

FOR A MASTERS DEGREE IN NS EDUCATION)

heerapj@unisa.ac.za

.....
I am happy to let my son/daughter (print name).....take part in the study.

- I agree that the interview can be recorded.
- I understand that the interview will be confidential.
- I understand that my son/daughter can stop the interview at any time.
- I understand that if my son/daughter does not want to take part, it will not affect him/her if help is needed in the future.

APPENDIX D

Assent letter to learners

26, Olifant Street,
Brackendowns,
25/08/2014

Dear Learners,

I am currently registered with the University of South Africa for a Masters Degree in Education with specializing Natural Science. Part of my Degree consists of a research study. I will be conducting research regarding factors related to poor science performance of senior phase learners: Case study at a school in Gauteng. It is vital to involve Grade 9 learners. As part of my research project on the Natural science learning area, I have developed a focus group interview and a questionnaire to determine the challenges in science learning and conceptual understanding of science concepts. The focus group consists of ten learners and will take about an hour and a half to complete. Five learners with test scores of 50% and higher, and five with scores below 50% were selected. I will be conducting the study on 23 October 2014. Your participation is, therefore, of most importance to the study and I would appreciate it if you could spare some time to participate in this study. Participation in this study is voluntary and involves no feasible risks or harm. You will be free to withdraw at any time without penalty, without giving any reason and without medical care or legal rights being affected.

The results of the study will be reported anonymously, and kept confidential. The names of the participants will not be identified.

Your co-operation will be appreciated. Please contact me (Mrs. JSR Anthony) at 0763933039, if you need clarity on any question about the study.

Best regards

Jasmin Anthony
(EDUCATOR AND STUDENT AT UNISA REGISTERED
FOR A MASTERS DEGREE IN NS EDUCATION)

Supervisor: Dr. P. J. Heeralal,
0124292318
heerapj@unisa.ac.za

.....

Please complete if you are happy to take part in the study

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without me medical care or legal rights being affected.

.....
PARTICIPANT'S SIGNATURE

.....
DATE



GAUTENG PROVINCE

Department: Education
REPUBLIC OF SOUTH AFRICA

For administrative use:
Reference no: D2015 / 167

GDE RESEARCH APPROVAL LETTER

Date:	23 June 2014
Validity of Research Approval:	23 June 2014 to 3 October 2014
Name of Researcher:	Anthony J.S.R.
Address of Researcher:	26 Olifant Street
	Brackendowns
	Alberton
	1448
Telephone Number:	011 868 3002; 076 393 3039
Email address:	jasmin.anthony32@gmail.com
Research Topic:	Factors related to poor natural performance of senior phase learners: case study at a school in Gauteng
Number and type of schools:	ONE Secondary School
District/s/HO	Ekurhuleni South

Re: Approval in Respect of Request to Conduct Research

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

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

1

Making education a societal priority

Office of the Director: Knowledge Management and Research

9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0606
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

1. The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.
2. The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.
3. A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.
4. A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.
5. The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.
6. Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.
7. Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.
8. Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.
9. It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.
10. The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.
11. The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.
12. On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.
13. The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.
14. Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.

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

Kind regards

David Makhado
.....

Dr David Makhado
Director: Education Research and Knowledge Management

DATE: *2014/06/24*
.....

2

Making education a societal priority

Office of the Director: Knowledge Management and Research

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

Appendix F Questionnaire

The purpose of the research is to determine the factors related to poor performance of senior-phase learners in science. Your contribution as a natural science teacher in this study is important to this research. Your honest response will be very much appreciated and will remain anonymous. This questionnaire has been compiled with specific reference to information obtained from the related focus group interview and document analysis.

Table 4.2 Section A. Educators' biographical and background details

1	Gender	Male		Female			
	Responses						
2	Age	20-30		30-40	40-50	50-60	
	Responses						
3	Ethnicity	B		W	C	I	Others
	Responses						
5	Years of Teaching experience	1	2-3	4-8	9-12	13-20	Over 20
	Responses						
6	Experience as natural science teacher	1	2-3	4-8	9-12	13-20	Over 20
	Responses						
7	Highest Academic / professional qualification	Teacher's Diploma		Higher Teacher's Diploma	Bachelor Degree(s)	Post-Graduate Degree(s)	Others
	Responses						
8	The grade you are currently teaching	Grades 8 - 12		7 - 9			

	Responses										
9	Status of your post	Permanent	Temporary	SGB post							
	Responses										
9	Your teaching level at school	Post level 1	Post level 2	Post level 3	Post level 4						
	Responses										
10	Type of School you are teaching	Public school	Private school	Others							
	Responses										
11	Language of teaching and learning	Afrikaans	English	others							
	Responses										
12	Your province	G	KZN	M	NW	L	FS	WC	EC	NC	
	Responses										

Section B

Please indicate your level of agreement with the probing statements contained in the following list by marking the appropriate square with a cross X.

Use the following scale

1: strongly disagree	2: Disagree	3: Neutral/undecided	4: Agree	5: Strongly agree	6: N/A
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Table 4.3 Section B Educators' responses of their perception towards natural science teaching in the classroom

	Questions		SD	D	N	A	SA	N/A
13	You are well trained in terms of the prescribed standards required by CAPS Senior Phase Natural Sciences (2011).							
14	You know the aims of NCS Gr. R-12(2012)							
15	You are well-acquainted with natural sciences learning outcomes and assessment standards.							
16	You know how to handle senior-phase learners.							
17	You know all science process skills and use it for learners.							
18	You set activities with science process skills.							
19	You try to clear away learners' misconceptions about science concepts.							
20	You motivate learners to attend science programs							
21	You vary the teaching strategies that you use in the classroom.							
22	You emphasis conceptual change to improve teaching and learning							
23	You use illustrative real-life examples to teach science concepts to learners.							
24	You use code switching to facilitate teaching where the language of learning and teaching is not the same as the learners' home language.							
25	Your learners are provided with resources, if not you make supplementary/remedial booklets for them							

26	You use Bloom's taxonomy in your assessment to develop learners' cognitive levels.							
27	You include practical in your science teaching program with a view to motivating learners to participate actively.							
28	I know the best method to teach science.							
29	I organize co-operative learning for learners							
30	My lesson plan is in line with my work schedule.							
31	I motivate learners to complete the many formal activities included as school-based assessment tasks in each term's teaching and learning programme							
32	I refer to the CAPS senior phase natural science document to check whether I am teaching the correct content.							
33	Learners' activities are calculated to meet the respective natural science learning outcomes and their associated assessment standards.							
34	In-service training sessions are provided by the facilitators to inculcate the conceptual framework considered appropriate for Senior-phase natural science.							

Indicate the factor (if any) that exerts the most profound influence on your science teaching. Mark the most appropriate response with a cross X

Table 4.4 Educators' responses in terms of Natural Science classroom climate

35	Not enough resources for learners	YES	NO
36	Large classes	YES	NO
37	Too many formal tasks per term	YES	NO
38	Incomplete formal tasks	YES	NO

39	Documents are in place	YES	NO
40	Classroom is conducive for teaching and learning	YES	NO
41	Enough charts and models in the classroom	YES	NO
42	Qualified and experienced to teach natural science	YES	NO
43	Lesson preparation contains learners' activities and assessments.	YES	NO
44	Subject facilitator provides support.	YES	NO

Schedule of interview with learners

Learners' responses to their background and reasons motivating their interest in learning science

Please indicate your response by writing the relevant number in the space provided:

Table 4.5 Learners' responses of their background details

45	Age	Less than 15	More than 15					
	Responses							
46	Gender	Male	Female					
	Responses							
47	Ethnicity	Black	White	Coloured	Indian	Other		
	Responses							
48	Your highest achievement level in science as noted in your progress report	L1 80-100	L2 70-79	L3 60-69	L4 50-59	L5 40-49	L6 30-39	L7 0-29
	Responses							
49	The mode of transport you use to travel to school	Car	Public transport	Walk	Other			
	Responses							
50	Your home language	Afrikaans	English	Isizulu	Setswana	Tsepedi	Sot ho	X ho sa
	Responses							
51	Subject choices in FET phase	Physical science	Life science	Both	others			
	Responses							
52	Type of school you are attending	Public school	Private school	Other				
	Responses							
	Language of teaching	Afrikaans	English	Isizulu	Other			

53	and learning.										
	Responses										
54	Your province	G	KZN	M	N W	L	FS	WC	EC	NC	
	Responses										

Table 4.6 Learners conceptions in the learning Natural Science

55	Classroom is conducive for learning	Yes	No						
	Responses								
56	Interest in learning science	Yes	No						
	Responses								
57	Remedial support from teacher	Yes	No						
	Responses								
58	Actively participate in practical	Yes	No						
	Responses								
59	Aware of CAPS 2012	Yes	No						
	Responses								

APPENDIX G FOCUS GROUP QUESTIONS

Questions scheduled for focus group interview with natural science teachers

1. What are the ways to develop learners' scientific knowledge?
2. How would you say that learners will gain a better understanding of science concepts and principles by applying theory to practical situations?
3. How do you rate learners' scientific literacy?
4. What are the reasons for your learners' poor performance in natural science?
5. What difficulties do you experience in teaching natural science?
6. How do you improve learners' performance?
7. How do you introduce science concepts to learners?
8. How often do you organise practical in your teaching?
9. What are the teaching strategies that you use to teach science concepts?
10. Which science discipline (Physical science, life science) are you specialised to teach?
11. What documents do you use as reference material to prepare lessons?
12. What are the factors that relate to senior-phase science learners' poor performance in science (i.e. to which senior-phase science learners' poor performance is attributable)?

Questions scheduled for focus group interview with learners

1. What are the reasons for your poor performance in natural science?
2. What difficulties do you experience in learning natural science?
3. How do you improve your science performance?
4. What are the challenges to which your poor science pass rate can be attributed?
5. Why do you find physical science preferable to life science?
6. What are the science disciplines that you would prefer to study/enrol for the in FET phase?
7. What is your career choice after school?

APPENDIX HCAPS lesson plan (Natural science Grade 7, 8 & 9)

DATE:		H.O.D./DEP.PRINCIPAL:				
TOPIC: Cells as the basic units of life		LEARNERS MUST BE ABLE TO:				
THEME: Differences between plant and animal Cells		• identify and explain the main differences between plant and animal cells				
SPECIFIC AIMS	1. DOING SCIENCE					
	2. KNOWING THE SUBJECT CONTENT & MAKING CONNECTIONS					
	3. UNDERSTANDING THE USES OF SCIENCES & INDIGENOUS KNOWLEDGE					
CONTENT		RESOURCES	APPROACH	LEARNER ACTIVITIES	ASSESSMENT	
					FORMAL	INFORMAL
<ul style="list-style-type: none"> plant cells differ from animal cells -- plant and animal cells are enclosed by a cell membrane, and plant cells also have rigid cellulose <i>cell walls</i> to provide support for the plant -- plant cells also contain organelles such as large vacuoles and chloroplasts. <i>Chloroplasts</i> contain chlorophyll to absorb light energy for photosynthesis (refer to Grade 8 Life & Living). Vacuoles in plant cells have several functions including support and storage (Vacuoles in animal cells are small and temporary or absent) 		<ul style="list-style-type: none"> Textbooks and other reference material 3 dimensional (3D) model of a cell, and/or pictures 	HINT: Use a statement or question to stimulate discussion amongst learners. Use models, films, investigations etc.	<ul style="list-style-type: none"> Activities from workbook/textbook can be used or self-designed. State the activity: 		
HOMEWORK		INDICATE TEXTBOOK/WORKBOOK BEING USED. ES WORKBOOK – PAGE				
SUPPORT/ENRICHMENT		RE-TEACH		TEXT ADAPTATION		PROF.GUESTS
		INDIVIDUAL ATT.		HANDS-ON APPLICATIONS		RESEARCH
		CORRECTIVE TEACHING		PEER INTERACTION		HIGH ORDER QUESTIONS
		VISUAL AIDS		ENGAGING NEW MATERIAL		ADDITIONAL ACTIVITIES
TEACHER REFLECTION						

APPENDIX I Annual Teaching Plan Natural Science Grade 9 2014

TERM	STRAND	TOPIC	TIME IN WKS	Week + Date	% coverage	Added % coverage	No of weeks	No of Informal Tasks
1	Life & Living	• Cells as basic units of life	2	20/01 – 31/01	5.88	5.88		6
		• Systems in the Human Body	2	03/02 – 14/02	5.88	11.76		6
		• Human Reproduction	2	17/02 – 28/02	5.88	17.64		6
		• Circulatory & Respiratory Systems	1½	03/03 – 12/03	4.41	22.05		4
		• Digestive Systems	1½	13/03 – 24/03	4.41	26.46	9 weeks	4
NB: Time for formal assessment will create deviation from above schedule time frames by +/- a week								
2	Matter & material	• Compounds	1	07/04 – 11/04	2.94	29.40		3
		• Chemical Reactions	1	14/04 – 17/04	2.94	32.34		3
		• Reactions of metals with Oxygen	1½	22/04 – 30/04	4.41	36.75		4
		• Reactions of non-metals with oxygen	1	02/05 – 08/05	2.94	39.69		3
		• Acids & Bases, and pH value	1	09/05 – 15/05	2.94	42.63		3
		• Reactions of acids with bases Part 1.	½	16/05 – 20/05	1.47	44.10		1
		• Reactions of Acids with bases Part 2	1	21/05 – 27/05	2.94	47.04		3
		• Reactions of acids with bases Part 3	½	28/05 – 30/05	1.47	48.51		1
		• Reactions of Acids with metals	½	02/06 – 04/06	1.47	49.98	8 weeks	1

TERM	STRAND	TOPIC	TIME IN WKS	Week & Date	% Coverage	Added % Coverage	No. of Weeks	No. of Informal Tasks	No. of Formal Tasks
3	Energy and Change	• Forces	2	21/07 – 01/08	5.88	55.86		6	
		• Electric cells as energy systems	½	04/08 – 06/08	1.47	57.33		1	
		• Resistance	1	07/08 – 13/08	2.94	60.27		3	
		• Series & parallel circuits	2	14/08 – 27/08	5.88	66.15		6	
		• Safety with electricity	½	28/08 – 01/09	1.47	67.62		1	
		• Energy & the National electricity grid	1	02/09 – 08/09	2.94	70.56		3	
		• Cost of electrical power	2	09/09 – 19/09	5.88	76.44	9 weeks	6	
NB: Time for formal assessment will create deviation from above schedule time frames by +/- a week									
4	Planet Earth & Beyond	• The earth as a system	1	13/10 – 17/10	2.94	79.38		3	
		• Lithosphere	2	20/10 – 31/10	5.88	85.26		6	
		• Mining of mineral resources	2	03/11 – 14/11	5.88	91.14		6	
		• Atmosphere	2	17/11 – 28/11	5.88	97.02		6	
		• Birth, life and death of a star	1	01/12 – 05/12	2.98	100	8 weeks	3	

Appendix J FORMAL ASSESSMENT REQUIREMENTS FOR NATURAL SCIENCES Grades 7, 8 and 9 as per CAPS (2011)

FORMAL ASSESSMENTS	TERM 1	TERM 2	TERM 3	TERM 4	TOTAL % FOR THE YEAR
School-based assessments	Test 1 *Practical task/ Investigation 1	Test 2 *Practical task/ Investigation 2	Test 3 *Practical task/ Investigation 3	*Practical task/ Investigation 4 ***Project	40%
Exams		**Exam 1 on work from terms 1 & 2		**Exam 2 on work from terms 3 & 4	60%
Number of formal assessments	2	3	2	3	Total: 100%

Appendix K

Natural Science Recording Sheet Grade 7- 9 2014 as per Department of Education

	TERM ONE						TERM TWO				
ACTIVITIES	PRAC.1	PRAC.2	PRAC.3	TEST 1	TEST 2	TOTAL	PRAC.4	PRAC.5	TEST 3	EXAM	TOTAL
DATES OF ASSESSMENT											
MARKS	20	20	20	40	40	100%	20	20	40	100	*100%

TERM THREE						TERM FOUR					PR.MK
PRAC.6	PRAC.7	PRAC.8	TEST 4	TEST 5	TOTAL	PRAC.9	PRAC.10	TEST6	PROJ.	EXAM	TOTAL
20	20	20	40	40	100%	20	20	40	50	100	*100%

Appendix L School Based Assessment

Curriculum & Instructional Studies prof Elize du Plessis(2013) Summary of assessments

SUMMARY OF ASSESSMENTS

GRADES	SUBJECT	TIME ALLOCATION (hours per week)	ASSESSMENT WEIGHTING	NUMBER OF FORMAL RECORDED TASKS					PROGRESSION AND PROMOTION	TOTAL HOURS			
				TERM 1	TERM 2	TERM 3	TERM 4	TOTAL					
Foundation Phase	Home language	min7/max8 (10 Gr R)	100% CASS	1	2	2	2	7	Codes 1-7 Promotion: 4 in Home Lang 3 in FAL 3 in Maths or Age cohort 'unless displays a lack of competence to cope with the following grade's work'	23			
	First Additional Language (no Grade R)	min2/max3		1	1	1(2)	1	4(5)					
	Mathematics	7		3	3	3	3	12					
	Life skills	Beginning Knowledge		1	1	1	1	1			4		
		Creative Arts		2									
		Physical Education		2									
		Personal and Social Well-being		1									
	Home language	min7/max8		100% CASS	1	3	3	2			9	Codes 1-7 Promotion: 4 in Home Lang 3 in FAL 3 in Maths or Age cohort 'unless displays a lack of competence to cope with the following grade's work'	25
	First Additional Language	min2/max3			1	2	2	1			6		
	Mathematics	7			3	3	3	3			12		
Life skills	Beginning Knowledge	2	1		1	1	1	4					
	Creative Arts	2											
	Physical Education	2											
	Personal and Social Well-being	1											
Intermediate Phase	Home language	6	75% CASS: 25% EXAM		2	2*	2	2	8	Codes 1-7 Promotion: 4 in Home Lang 3 in FAL 3 in Maths 3 in any 2 other subjects or Age cohort 'unless displays a lack of competence to cope with the following grade's work'	27.5		
	First Additional Language	5			2	2*	2	2*	8				
	Mathematics	6			3	3	3	3*	12				
	Science and Technology	3.5		2	3	3	4*	12					
	Social Sciences	Geography		3	1	1	1	1*	4				
		History		1.5	1	1	1	1*	4				
	Life Skills	Creative Arts		1.5	1(CAT)	1(CAT)	1(CAT)	1(CAT)	4				
		Physical Education		1	1(PET)	1(PET)	1(PET)	1(PET)	4				
		Personal and Social Well-being		1.5	1	1	1	1*	4				
Senior Phase	Home Language	5	40% CASS: 60% EXAM	4	4*	4	2*	14	Codes 1-7 Promotion: 4 in Home Lang 3 in FAL 3 in Maths 3 in any 3 other subjects 2 in any 2 other subjects Note 'No learner should stay in the same phase for longer than four years, except under exceptional circumstances.'	27.5			
	First Additional Language	4		4	4*	4	2*	14					
	Mathematics	4.5		3	3*	3	2*	11					
	Natural Sciences	3		3	4	3	4*	14					
	Social Sciences	3		1+1	2+2	1+1	2+2*	12					
	Technology	2		1	1	1	1*	4					
	Economic Management Sciences	2		2	2*	2	1*	7					
	Life Orientation	2		2	2	2	2*	8					
	Creative Arts	2		1	2	1	2*	6					
Further Education and Training (FET)	Home Language	4.5	25% CASS: 75% EXAM	4	2*	3	3*	12	Codes 1-7 Promotion: Obtain at least 40% (3) in Home Language Obtain at least 40% (3) in any two other subjects Obtain at least 30% (2) in any three other subjects	27.5			
	First Additional Language	4.5		4	3*	3	3*	13					
	Mathematics or Mathematical Literacy	4.5		2	2*	2	1*	7					
	Life Orientation	2		2(1PET)	2*(1PET)	2(1PET)	2*(1PET)	8					
	Subject Choice 1	4		2	2	2	1*	7					
	Subject Choice 2	4		2	2	2	1*	7					
	Subject Choice 3	4		2	2	2	1*	7					
	Home Language	4.5		5	3*	1*or 2	2*	11 or 12					
		First Additional Language		4.5	4	4*	3*	2*			13		
		Mathematics or Mathematical Literacy		4.5	3	2*	2*	1*			8		
Life Orientation		2	2(1PET)	2*(1PET)	2*(1PET)		6						
Subject Choice 1		4	2	2	2	1*	7						
Subject Choice 2		4	2	2	2	1*	7						

* Indicates that one of the assessments is an examination
The figures in the tables do not include the baseline testing or Annual National Assessments (ANA).