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TITLE OF THESIS

Western Cape Senior Phase Learners' Conceptions of Magnetism, Chemical Change of substances and the Environment

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DECLARATION

I declare that "***Western Cape Senior Phase Learners' Conception of the concept of Magnetism, Chemical Change of Substances and the Environment",*** is my own work; that it has not been submitted before for any degree or examination at any other University, and that all the sources I have used or quoted have been indicated and acknowledged as complete references.

ELIZABETH IDOWU AYANO

SIGNED: ……………DATE: May, 2018

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May God continually be praised in His Holiness and Majesty.

DEDICATION

The research work is dedicated to the Almighty God who spared my life and saw me through the Masters' programme.

ABSTRACT

A large percentage of South African learners held inadequate or alternative conceptions that might hinder them from developing a valid understanding of various scientific concepts and generalizations. This study explored the conceptions of Senior Phase learners on magnetism, chemical change of substances and the environment. More explicitly, the study attempted to investigate the influence of the learners' age, language and gender issues on their understanding of these scientific concepts. The study is underpinned by socio-cultural constructivism as espoused by Vygotsky (1978).

The research sample comprised 250 Senior Phase learners (grades eight and nine) from secondary schools in the Metro Central District in the Western Cape. The study used the following six research instruments for data collection: Science Achievement Test (SAT), Context Test, Cloze Test, Picture Test, Science Vocabulary Test and an interview schedule. The tests were administered to all the participants while the interview was conducted with six participants.This study was a descriptive research of a survey type and data was collected and analyzed using both quantitative and qualitative methods.The data collected was analyzed quantitatively using the Statistical Package for Sciences (SPSS) in order to obtain descriptive statistics that were used to explore the conceptions of senior phase learners in magnetism, chemical change substances and the environment in the Metro Central district while data from the tape recorder and notes taken during the interview, were analyzed qualitatively.

The analysis of the data showed that learners who participated in this study have a weak perception of the three concepts; magnetism, chemical change of substances and the environment. However in both grades, the girls seemed to have better conceptions of the concepts than the boys. In terms of age, the younger learners appeared to hold better conceptions of the three selected concepts than the other age groups. With respect to language, the English speaking group seemed to demonstrate a better understanding of the concepts than the other groups.

However, based on the statistical analysis of the scores it was found that the differences between the boys and the girls were only significant in terms of language but not in terms of age and gender. Incidentally, this finding accord with earlier findings in the area (e.g. Ogunniyi, 1998; Rollnick & Rutherford, 1996). This study offers several recommendations for the stakeholders e.g government, school administators and educators to consideras well as suggests waysthat could be used to improve learners' conceptual understanding of these selected concepts.

KEY WORDS

Nature of science

Science learners

Conceptions

Alternative conceptions

Scientific concepts

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ABBREVIATIONS AND ACRONYMS

CAPS	Curriculum and Assessment Policy Statement
CCM	Conceptual Change Model.
CHEM	Chemical change
CLT	Cloze Test
COS:	Classroom Observation Schedule
COT:	Context Test
EDUHDC:	Education Higher Degrees Committee
ENV:	Environment
FET:	Further Education and Training.
LOLT:	Language of learning and teaching
MIAB:	My Idea about Acids and Bases.
MIM:	My Idea about Magnetism.
MKO:	More knowledgeable than other
NCE:	National Certificate Examination
NOS:	Nature of science
NSE:	National Senior Certificate Examination
OBE:	Outcomes- based education
PIT:	Picture Test
P-PRIMS:	Phenome logical primitive.
SAT:	Science Achievement Test
SES:	Socio-economic status
SHDC:	Senate Higher Degree Committee
STAP:	Science through Application Projects
STLP:	The Scientific and Technology Literacy Projects (STLP)
STS:	Science and Technology for Society.
SVT:	Science Vocabulary Test
TIMSS:	Trend in International Mathematics and Science Studies.
UWC:	University of the Western Cape
WCED:	Western Cape Education Department
ZPD:	Zone of proximal development

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CHAPTER ONE

BACKGROUND AND ORIENTATION TO THE STUDY

1.1 Introduction

It has become an established fact that the majority of learners in South African schools are not positively disposed to the study of science. In fact, less than a third of the school population enrol in science beyond secondary school level. According to Mushtaq and Khan (2012) and Enu, Agyman and Nkum (2015), factors such as irrelevant science curriculum, poor school environment, background and classroom practices have contributed to learners' negative interests and attitudes towards school science.

The consequence of this trend therefore, has been the shortage of scientific and technological personnel in the country (Ogunniyi, 1998a). To a large extent, a nation's socio-economic development depends on scientific and technological development.In the same vein, a country without comprehensive technological development is not likely to have a strong workforce that is equipped with cutting edge scientific and technological knowledge and skills (Ejidike & Oyelana, 2015).

It can also be assumed that a country that advances in science and technology would have a better chance to compete successfully in the modern scientific/technological and market -driven economy. However, it is worth noting that scientific/technological development ultimately depends on the quality of science teaching at school level (Mlambo, 2011; Mbugua, Kibet, Muthaa, & Nkonke, 2012; Wang, 2015).

Science education is a field of study that is concerned with creating a world that is scientifically oriented. It provides learners with opportunities to acquire certain basic knowledge, skills, and attitudes for scientifically oriented tasks, which in turn depend on such attributes as critical thinking and creativity needed for problem-solving and rational decision making. Canuel (2011) argued that if education is meant to prepare learners for their world, greater priority must be given to science and technology in our classrooms and schools. Likewise, Burmeister, Rauch and Eilks (2012) have argued that science and technology constitutethe economic heart of every highly-developed industrialized and technologically advanced society. If their contention is valid, then it seems imperative for learners to acquire the basic concepts of science which form the basic bricks and mortar of science and technology. According to Ogunniyi & Mikalsen (2004), and Ogunniyi & Taale (2004) scientific concepts provide the basic meanings for scientific terms and without them, not much progress can be made in the fields of science and technology.

A proper understanding of major concepts in science is likely toenhance students' performance as they interact more with the subject in higher education. Howie (1997) argues that poor conceptualisation of major concepts in science could result in students experiencing challenges in attaining high performance in the subject as has been the case in the low rating of South African learners in the Trend in International Mathematics and Science Studies (TIMSS) over the last decade.

Generally, the efforts demonstrated by South African learners to show their conceptualisation of major concepts in science is largely done through the memorization of facts as opposed to proper conceptualizationof such concepts. The consequence is that learners, in the absence of meaningful learning of the basic concepts in science, tend to struggle in their understanding of the subject.This seems to suggest the need to correct learners' poor conceptualisation of scientific concepts and to put them in better stead to study science beyond primary school level (Christie, 2008; Heeralal, & Dhurumraj, 2016).

Okoye (2002) stressed that learners from a better socio- economic background are more motivated and often show a more positive attitude to their studies. KadarAsmal, the former Minister of Education was cited in a report of the Discovery Centre (2000-2001) as stating that:

By comparison with other middle-income countries, our learners perform very badly in internationally standard tests in Science and Mathematics. School leavers become

job seekers or enter high school with serious gaps in fundamental knowledge, reasoning skill and methods of study.

A child with a good foundation in science will have a better chance of performing well in science at high school and tertiary institutions. The role of primary school educators in preparing learners for high school education cannot be overemphasized. Chang, Chin and Hsu (2008) and Nnachi (2009) and Al-Rawajfih, Fong and Idros (2010) opined that in developing nations, educators are influential personalities who make change happen, take responsibility for science and technology and enhance curriculum implementation in the schools due to their positions in policy making.

A review of the extant literature shows that the majority of our educators (science teachers) at both primary and secondary levels do not have a good knowledge of science (Shallcross, Spink, Stephenson & Warwick, 2002; Muwanga-Zake, 2000). Furthermore, Shallcross et al. (2002) have stressed that confidence is the major element of effective science teaching. Without this, learners enrolled in high schools with a poor science background are unlikely to be favourably disposed to the study of science.

There is a general consensus among science educators that teaching science in an effective way is critical to stimulating and sustaining learners' interest in science. In the same vein, researchers, as well as education policy makers are concerned about improving science teaching and learning from the basic school level.

For instance, the Scientific and Technology Literacy Project (STLP), based at the University of the Western Cape, carried out a series of assessments to determine the problems encountered by South African Primary and Secondary school learners in science and to implement necessary instructional strategies to solve such problems (Ogunniyi, 1999). STLP developed several instruments to diagnose grade 7-9 learners' cognitive, psychomotor and affective readiness for the interim syllabus for Curriculum 2005 (C2005).

The results of that study showed that less than one-third of grade 7-9 learners that participated in the study scored above 40% in all topics covered in that syllabus. Considering the poor performance (i.e. less than 50%) of grades 7-9 in the STLP study, it seems that only a small percentage of the learners were cognitively ready to pursue science in further education.

Ogunniyi (1999) also refers to the Science through Applications Project (STAP) at the University of Western Cape which was instituted in April 1995 as a curriculum research project aimed at addressing some of the challenges facing the teaching and learning of science. Despite the painstaking attempt by STAP to develop learning programs and curriculum materials that support a science and technology for society (STS) approach as well as presenting learners with science that is more contextually relevant to them their overall performance was still poor.

A lot has been written about the low performance of learners in science and other science-related subjects in South Africa (e.g. Makufuta, 2016; Pereina, 2010; Spaull 2013; and Kriek and Grayon, 2009). However, it is evident that if this present state of affairs persists, South Africa would not be able to participate as it should to bring about a radical change that could enable her to participate actively in the present remarkable revolution currently taking place in science and technology.

1.2 Background to the Study

Today, in many nations around the globe emphasis has been placed on research work dealing with improving learners' academic achievement. In particular there is great concern about the general performance of learners in science and their overall level of scientific literacy and why learners are not showing interest in pursuing careers in science or to study science. Lyons (2006) posits that there is a similar anxiety in Australia where there has been a large decrease in students erolling in science classes. This has attracted great concern about scientific, literacy, and technological expertise in Australia.

Furthermore, Science Educators around the world share related concerns (Mucana, 2013, Spuall, 2013, & Pereira, 2010). Weiman (2014) asserts that efforts made over decades to improve the quality of science , technology and mathematics in the United States has not resulted in an improvement.

In South Africa, the generally low standard and poor performance of learners in science are not unrelated to the legacy of apartheid policies. The implementation of these policies in the education system (including science education) has had a devastating impact on learners' performance in science. After all, science achievement is largely a direct outcome of the quality of the instructional process.

As a result of the education system, the educators that were trained, especially in the non-white areas, lacked adequate instructional materials, content knowledge and pedagogical knowledge to teach science (Diwu & Ogunniyi, 2012) because the educators were poorly prepared for their instructional tasks and consequently they produced poor learners (Naidoo & Lewin, 1998).

It is quite noticeable that apartheid in South Africa did not only cause people to live at a disadvantages because of their race, but also, they could not claim their right to quality education. The impact of the apartheid system prevented the country from making adequate use of its human capital and material resources. I shall try to elaborate this further in the sections that follow.

The South African education system has undergone a remarkable transformation since the demise of the apartheid government. For instance, the former 19 deparments of education have been combined into a single National Department of Education. The transformation was inevitable because the apartheid curriculum was based on an unjust system. It separated people in the same country according to their colour of skin and associated cultural bias, placing the caucasoid citizens above all the others-a practice that has caused so much human suffering and inequality, still evident in South Africa today.

To ameliorate the ills of the apartheid system of education, the new democratically elected government embarked on a massive curriculum transformation. For instance, the curriculum, which was once based on race, has been replaced by one that is inclusive and relevant to all learners, regardless of their socio-cultural differences. However, this does not imply that the impact of the former apartheid system of education has been eradicated completely. The previously disadvantaged learners of colour still perform lower than their white counterparts in most school subjects including science. But before going into this, it is apposite to clarify the notion of the curriculum adopted for this study. What is a curriculum?

The term curriculum has been defined in a variety of ways. However, the most commonly accepted definition is that the term refers to all the experiences which the school provides for its students, to stimulate and promote learning on their part (Mustaq & Khan, 2012). However, in this study the focus is on the subject matter that educators attempt to impart to learners e.g. school science.

Many authors have suggested the need for a new curriculum to pay close attention to the learners' socio-cultural environment so as to make it relevant to their world. In other words, it should pay attention in terms of how things will unfold in practice so that education will be more applicable to African contexts and new dispensation goals for meaningful learning to occur (Rogan, 2007; Mayer, 2002).

While it is important for a curriculum to pay close attention to the sociocultural context of learners, it is equally impotant to determine in a comprehensive way e.g. through assessment,where the learners are in comparison to other learners worldwide. TIMSS and similar international assessments are premised on these assumptions.

In other words, in the era of globalization and science driven economies whatever science is taught or learned in any country should be comparable to what takes place in other countries. No doubt, there is the urgent need to assess the various factors that are influencing learning, performance, and assessment especially in the course of an ever-changing curriculum (Faatar, 1997) but this has to be done in a gradual and systematic way.

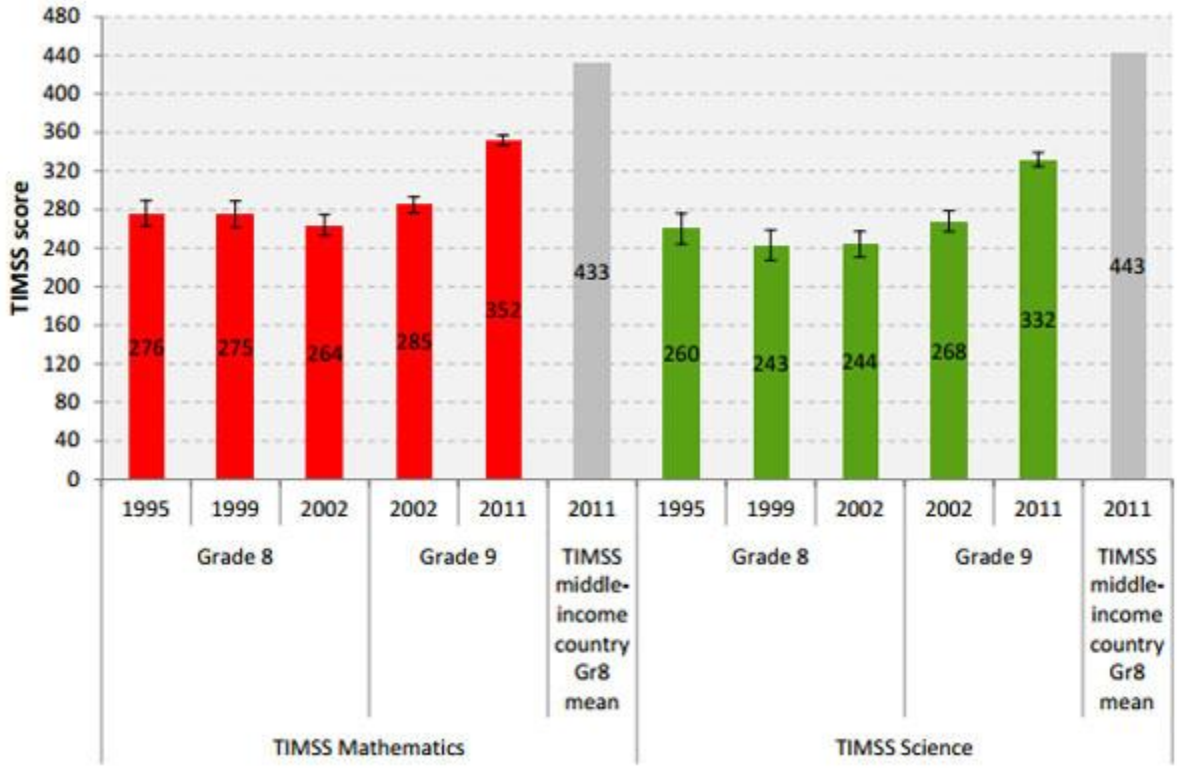
The present study, like the earlier ones, is another attempt to monitor learners' understanding of selected science concepts but is also an indirect way of assessing the quality of teaching in definite areas of the science curriculum. Although most of the ealier projects focused on foundation (grades 1-3) and intermediate phases (grades 4-6), a few have targeted the Senior Phase (grades 7-9) as well. An example of such assessment programs has been the Trends in International Mathematics and Science Studies (TIMSS).TIMSS evaluates mathematics and the science knowledge of grades 8 and 9 (Reddy, 2006).

South Africa has been taking part in TIMSS for about two decades. TIMSS was first conducted in South Africa in 1995. However, the outcome of the studies over the years have consistently revealed the poor performance of South African learners compared to learners in the other countries that have taken part. This suggests that majority the learners in South Africa have not acquired the essential knowledge and skills in science and mathematics.

In spite of all the efforts that have been made, the underperformance of learners in the National Senior Certificate Examination (NSCE) in the sciences and other related subjects and in the international assessments has been a serious indictment of our educational system and which warrants urgent action by all stakeholders .

The examination results published in the last three years indicate that there has been no significant improvement in the performance of the learners in the physical sciences. Furthermore, scientific literacy among South African secondary school learners remains lower than desirable. This has also been the problem for many years (Kriek & Grayson , 2009). In view of this, it is necessary to look for a way of reversing this trend so that it would ultimately benefit the learners and the nation at large. The figure and the table below show the performance of South African learners in TIMSS from 1995-2011 and the trend in the performance in the physical science curriculum (2012-2015).

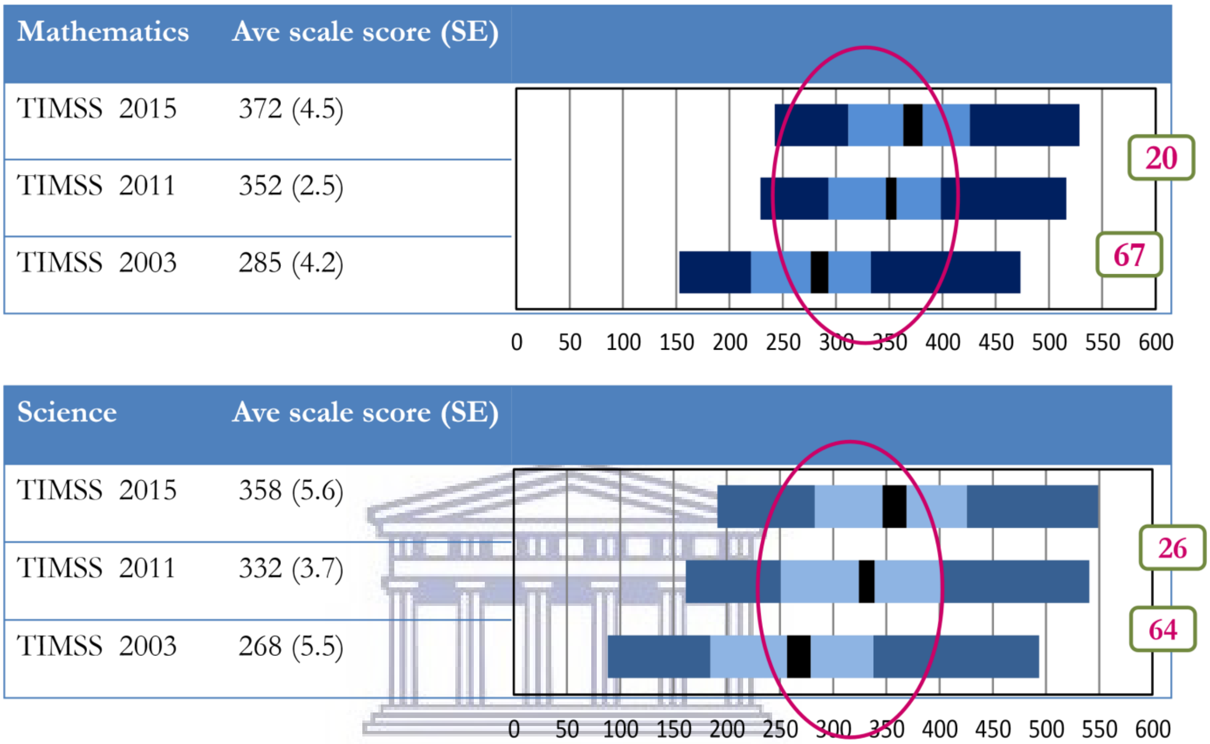
Figure 1.1: TIMSS results from 1995 to 2011.



Source: mybroadband.co.za/ news/ government/124024 .

Figure 1 above shows the average performance of South African grade eight and grade nine learners in TIMMS as well as the error bars for the 95 per cent confidence interval around the mean. From Fig. 1 we can deduce that although there was a great improvement between 2002 and 2011, South African learners still lag noticeably behind the TIMSS middle-income countries in the grade eight mean for both mathematics and science. In TIMSS 1995, 1999 and 2002 there was no discernable improvement among grade eight learners in either mathematics or science and even the slight changes over this period were not statistically significant (i.e. one cannot rule out that they occurred by chance). However, between TIMSS 2002 and TIMSS 2011, the average performance for grade nine learners in both mathematics and science increased by 67 points and 64 points respectively (Reddy, Prinsloo, Arends, Visser, Winnaar, Feza,Mthethwa, 2012).

Figure 2.2: South Africa: Grade 5 and 9 learners' achievement in Mathematics and Science (2003 -2015).



Source:TIMSS (2015) Grade 5 and Grade 9 performance Trends in International Mathematics and Science Study.

In Figure1.2 above, South Africa shows a higher improvement in TIMSS 2015 compared to the previous reports. Grade 5 and 9 learners in Mathematics and Science increased by 87 and 90 points respectively. This is an unexpectedly large increase in performance, and provides a strong indication that learning outcomes for Grade 9 pupils in mathematics and science have improved over the 2002-2015 period. On the other hand, it must be noted that South learners' achivement in mathematics and science improved from 'very low' to a 'low' national average. Although this is a positive outcome, there is still room for improvement relative to learners in other countries. In other words, the eagerness to perform even better in the next TIMSS should be the goal. (Reddy, 2006).

Table 1.1 Performance Trends in Physical Science (2012 –2015)

Year	No wrote	No achieved at 30% above	% achieved at 30% at above	No achieved at 40% and above	% achieved at 40% and above
2012	179194	109918	61.3	70076	39.1
2013	184383	124206	67.4	78677	42.7
2014	167997	103348	61.5	62032	36.9
2015	193189	113121	58.67	69699	36.1

Source: NSC 2015 Diagnostic Report.

The number of candidates increased by 25192 in comparison to that of 2014.The general performance of candidates declined in 2015, as indicated by 58.8% of candidates achieving 30% and above with 36.1% achieving 40% and above.It might be interesting to know what the percentage is of the learners who scored 50% or above. The likelihood is that it would be less than 30%.

The implications of learners' continued poor performance in science is certainly worthy of closer consideration by assessment researchers. The scenario depicted in Fig1.1 and Table 1 .1 above forms the basis ofthis study particularly considering the importance of the Senior Phase as a useful indicator of learners' potential for studying science relative to magnetism, chemical change and the environment.The three selected concepts in this study are considered to be essential topics in Natural Science in the senior phase and a basis for further study in science at the Further Education and Training (FET) level of education.

1.3 Statement of the Problem

The current state of teaching and learning of science, especially the poor performance of learners in science and other science-related subjects in South Africa, has put the government and society at large in a dilemma. Pereira (2010) stresses that learners' performance at both primary and secondary school levels does not appear to have improved significantly over the past 10 years. More than 50% of all learners in South African schools who wrote mathematics in 2008 failed that examination. Mafukata (2016), who attempted to determine the patterns of learners' performance in physical science also stated that learners' performance have not improved.Kriek and Grayson (2009) state that the performance of learners in science learning across the nation particularly Mathematics and Physical Sciences has been discouraging since

2003.This defeats the intended outcome of producing potential scientific personnel among South African learners.

The extant literature has revealed that many learners view science as a difficult subject involving mainly number crunching and having no appeal to their intellectual interests (Ogunniyi, 1999). Possible reasons include poor scientific literacy, non-compliance with the Curriculum and Assessment Policy Statement (CAPS), inability to grasp science concepts, as well as misconceptions or more appropriately, alternative conceptions of science.

Other factors relate to cumulative deficits, arising from ineffective practical work, non completion of required formal assessments, difficulties in learning science in a second language, learners' inability to cope with increased academic demands, and lack of adequate involvement with stimulating academic activities (Csikszentmihalyi & Schneider, 2008; Howie, Scherman & Venter, 2008; Bond &Wasik, 2009; Muralidhar,1991 & Msimang ,1992).

One of the common weaknesses of the old science curriculum and which has been well articulated in the Outcomes-Based Education (OBE) Curriculum 2005 (C2005) has been the assumption of commonality of knowledge among learners. Considering the current theories of educational psychology, this assumption is no longer valid. Individual differences in all areas of life are quite noticeable, even within the same culture. It is for this reason that Piaget's levels of cognitive development have been criticized: even if such categorizations were true, it could not be true of the present multicultural classrooms in South Africa.

Formal assessments do not assess the curriculum standards for the grade, teachers' failure to prepare a lesson plan, the inadequacy of creative activities with a view to remediating in the sense of improving achievement and attitudes towards science beyond thelevels achieved with conventional text-based teaching. Consequently, this affects the performance of students in science and also reduces their choice of science in further studies (Osborne, Simon & Collin, 2003; Babad and Tayeb, 2003). This study is concerned about improving science perceptions of senior phase learners, particularly grades eight and nine.

1.4 Rationale for Study

My experience as a teacher is that a considerable percentage of learners that enter my class regard science as a difficult subject. Some of the learners conclude that the workload is too much while others say it requires a lot of time and critical thinking. The different opinions among scholars about why many learners find science difficult include: the abstract and counter-intuitive nature of science; the quality of instruction; learners' conceptual deficits; the availability of learning resources; learners' inadequate opportunities for classroom discourse; fact-oriented examinations and so on (Christie, 2008; Heeralal, & Dhurumraj, 2016).

Mullins (2005) has stated that many learners tend to avoid physical sciences because of their fear of the subject and a lack of self-confidence. This negative attitude results in underperformance which can prevent them from having therequired results for university entrance. Whatever the cause may be, it is clear that a general fear of science exists among learners which affect their interest in science and related subjects.

As stated earlier, South African learners performing poorly in both national and international assessments such as Matric and TIMSS 1995-2011 (Reddy, 2006). For instance, their performance in science in 2013 is poorer than it was in 1998. Likewise, their performance is still based on racial lines as a result of inequalities created by the apartheid system of education. Also, Annual National Assessment results for grade 12 physical science have recently deteriorated.

From the foregoing, it can be assumed that learners' poor performance, both in national and international assessments, provides a useful indicator, not only for monitoring and predicting their future achievement in science but also in their career choices. The driving motivation for this study therefore is to find ways and means to increase learners' enrolment in science and that of course to a large extent on their performance at the lower levels of education, particularly grades 7-9, which forms the transistion between primary and senior phase.

This study is premised on the assumption that by exploring grade 8 and 9 learners' perceptions of magnetism, chemical change of substances and the environment, one could begin to gain some insight into their potential for studying these science concepts and perhaps others in the future. It is hoped the findings from the study would help to identify appropriate teaching and learning strategies to assist teachers in improving the learners to gain a deeper and richer conceptual understanding of these concepts and related concepts.

1.5 Purpose of the study

While there is a general consensus about the urgent need to improve the teaching and learning of science, not much is being done to assess learners' understanding as a way to identify appropriate or remedial instructional approaches. Rather, assessments are generally used for judgmental rather than formative purposes.

I. In view of the poor performance of learners in international comparative studies such as TIMSS, the findings of this study may be of interest to the South African Department of Basic Education (DBE), school principals, and educators, in their attempt to implement the new CAPS curriculum.

II. It is also hoped that the findings would provide useful information about possible sources of epistemological obstacles preventing grade eight and nine learners from mastering the concepts of magnetism, chemical change of substances and the environment.

III. The findings might provide additional insight into possible influences of age, gender, and language on grade eight and nine learners' conceptions of magnetism, chemical change of substance, and the environment.

1.6.1 Research Questions

The focus of this study is to determine grade eight and nine learners' conceptions of selected science concepts and how factors such as age, gender and language influence such conceptions. In pursuance of this aim, answers to the following questions were sought:

1. What conceptions of magnetism, chemical change of substances and the environment do grade eight and nine learners hold at selected high schools in Cape Town?
2. Is there any correlation between the learners' age, gender and language and their conceptions of magnetism, chemical change and the environment?

1.7 Theoretical Framework

Cresswell (2009) stated that a theoretical framework explains the theories that underpin a research work. It guides researchers in determing the direction of a given study and also clarifies how the researcher's assumptions about the concepts used are related to the intended study. Furthermore, it serves as a platform on which research design, procedures for data collection, analyses and interpretation, are based. The theory that underpins this study is socio-cultural constructivism as advocated by Vygotsky (1986). The next section provides more details about socio-cultural constructivism in relationship to the teaching-learning process.

Socio -cultural Constructivism

Socio-cultural constructivism theory as espoused by Vygotsky (1978) stresses the importance of social interaction in the cognitive development of learners. Vygotsky (1978) stresses further that the socio -cultural environment of learners helps to shape their beliefs, interests, values and perceptions about the world around them. In other words, a child's holistic development cannot be separated from the environment in which he/she has been brought up. As a learner relates to people and objects around him/her, he/she begins to internalize the experiences and to mobilize same to behave in one way or the other. It is the same sociocultural environment that gives him/her the language with which to think, communicate,and externalize his thoughts, as well as participate in various social activities including learning.

Vygotsky (1978) believes that when a learner comes into the classroom he/she has already formed ideas about various phenomena, though such ideas might be rudimentary, inadequate and even faulty. In this regard, it is the responsibility of the teacher to first determine the nature of the learner's conception before introducing new ideas to him/her. In other words, the teacher should not assume that a learner has an empty mind to be filled with knowledge.

Current conceptualization of socio-cultural constructivism is based on Vygotsky's (1986) work as well as other theorists such as Wretch, (1991,1998).Vygotsky and associates emphasize the role that learners' environment, and the people that they interact with (including their culture), play, in shaping their beliefs, perceptions and attitudes. Social constructivism also stresses the fact that one that cannot be divorcedfrom the social happenings around him/her. It further suggests that higher order functions develop as people communicate and relate to each other.

Sutherland, Armstrong, Barnes & Brawn (2004) stress further that the exceptional thing about socio-cultural constructivism is the fact that certain devices or tools mediate human actions or learning. In other words, the theory places emphasis on social interactions enacted by humans in a social setting. For instance, interactions such as those happening in the classrooms between educators and learners, happen in a social setting that is predisposed by universal and local factors such as the curriculum.

Opposing the concept of tabula rasa, socio-cultural constructivism identifies the various learner experiences brought to the classroom, deriving both from social interactions (outside the classroom) and class interactions. Tharp and Gilmore (1988) opined that the socio-cultural perspective has thoughtful implications for teaching, schooling and education, especially in language teaching and learning. Its strength lies in the fact that it identifies the role of social interactions as individuals build knowledge and negotiate meaning in real world situations while acquiring language skills (Lantolf & Poehner,2008; Lantolf & Thorne, 2007).

According to Lim, Vygotsky's socio-cultural theory is ideal for learning because it has many concepts that can be applied in many other learning institutions, particularly, conjoining cognition with activities. This is particularly because higher mental functions are said to be happening on two planes, namely the social and psychological (Lim, 2002a). The social plane is referred to as the inter-psychological class, happening between people while,the other is an intra-psychological class, happening within an individual learner. Lim (2002a) further highlights further the fact that human mental functions as claimed by Vygotsky, are mediated by culturally embedded tools, both technical and psychological**.**

From the foregoing, this study is premised on the belief that socio-cultural constructivism is an appropriate theoretical framework for exploring grade eight and nine learners' conceptions of magnetism, chemical change and the environment and is a valid basis for recommending remedial instruction. However, as Bentley and Fleury (2016) have argued, the much projected views of social constructivism are on the trivial, rather than the deeper aspects, which entail critical reflection, imagination and social consciousness and which refer to the importance of what is taught or learned. This issue will be elaborated on in chapter 2.

1.8 Delimitation of the study

Glatthorn and Joyner (2005) define study delimitation as the boundaries of the study and ways in which findings may lack generalisation. Hence delimitation deals with the scope of a study. Generally speaking, a study of this nature should involve a large number of learners so that a reasonable generalization can be made. However, to undertake an in-depth qualitative study would warrant the need to keep the sample small as well as limit the number of the concepts that could be investigated as has been the case of this study. In addition, only a sample of the willing learners were interviewed. In other words, the study was based on purposive sampling and therefore the result was not generalized beyond the sample.

In light of the difficulties encountered in obtaining information from classrooms nowadays, the dynamics of the school setting, and in comformity with the sociocultural constructivist theory underpinning the study, purposive sampling seemed most apposite (Maxwell, 2005) In addition, as presented in the curriculum, it is science-oriented-an area which I am more familiar with than the social sciences I have accordingly selected scientific concepts pervading the grade eight and nine natural science curricular which would be of interest to the learners.

The available sample size was used and therefore the result could be not be generalised beyond the specific situation as the study was limited to three topics namely magnetism, chemical change and environments in a few schools,although the findings are applicable to the entire schooling system. Duit and Treagust (2003) stress that from a epistemological view, conceptual change is explored based on the learners' different interpretations of concepts being examined while from the ontological view, conceptual change is studied based on how learners view the nature of a concept being investigated.

According to Chi (2008) one of the most important factors in concept learning is motivation. Learners' motivation, though important, was not explicitly examined in this study. Therefore, in terms of scope, the study was limited to epistemological and ontological conceptual changes that emerged from the data since the study involved no intervention.

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1.9 Operational Definition of Terms

Worldview: To Kearney, "worldview is a culturally organised macro-thought; those dramatically interrelated assumptions of a people that determine much of their behaviours, decision making, as well as organising much of their body or symbolic creations……and echo-philosophy in general" (Ogunniyi, Jegede, Ogawa, Yandila & Oladele, 1995, p.818**).**

Concept: According to Wikipedia, concept is a mental symbol or an abstract idea about the nature of a given subject matter, drawn from an individual's experience or the result of transformations of existing ideas. Kikas (2010) stresses that learners 'concept about a given matter is important for learning. It influences the learners' understanding and interpretation of new information while learning in school.Specifically, scientific concepts are the meanings attached to scientific terms. They form the blocks for scientific generalizations (Ogunniyi, 2006).

Alternative conceptions: Alternative conceptions are conceptions held by learners, which originated from their own interpretations, experiences and explanations in their early years which may differ considerably from scientific facts (Smolleck, 2011).

Constructivism: Constructivism is a worldview or philosophical framework which construes learning as an active and constructive process through experiencing things and reflecting upon them. According to Taylor (1997), constructivism is a theory of epistemological inquiry that empowers teachers to draw the thread of being from life and weave it into their emerging pedagogies.

Sociocultural theory: Socio-cultural theory is a theory of development that takes cognizance of the sociocultural environment.Current conceptualization of social cultural theory is based on Vygotsky (1986) as well as other theorists such as Wretch (1991).

Culture: Culture is the overall lifestyle of a society and the way it deals with reality (Ogunniyi, 2005). According to Phelan, Davidson and Cao, these include norms, values, beliefs, worldview, skills and behaviour and technology (Aikenhead, 1986).

Physical Science: According to the Department of Education (2003), Physical Science focuses on investigating physical and chemical phenomenon through scientific enquiry by applying scientific models, theories and laws. It seeks to explain and predict events in our physical environment. (Department of Education 2003)

Outcomes–Based Education(OBE): Outcomes–Based Education forms the basis for the newcurriculum in South Africa. It strives to allow all learners to attain their learning potential by setting the learning outcome to be achieved by the end of the education process (Department of Education 2003, p.2).

1.10 Structure of the thesis

This thesis is divided into five (5) chapters, as described here under:

Chapter one: Setting the scene

This chapter is divided into introduction, the background (which looks at the state of science education and the performance of the learners), the problem statement highlighting the rationale for exploring the conception of learners in some scientific concepts, the conceptual underpinnings of teaching and learning, the purpose of the study ,which is to present in a refined and crisp manner the research questions and the significance of this study. In addition the chapter provides the limitations, delimitations of the study and the operational definitions of terms.

Chapter two: Literature Review

This chapter focuses on the theoretical issues that surround teaching and learning and the effects of age, gender and language on the conception of learners in science and their worldview. Finally, practical consideration and the theoretical framework guiding this study was explicated and elaborated upon.

Chapter three: Research Methodology

This chapter discusses the setting of the research site, and the sample selection procedure. It also provide the details of the research paradigm, including the research design, research instruments and how they were validated and detailed for ease of reference. The chapter concludes with data collection, analysis and ethical considerations.

Chapter four: Presentation of Data and Data analysis

This chapter presented the analysis and discussion of the data. The chapter concludes with the summary of the findings.

Chapter five: Findings, conclusions and recommendations

This chapter presented the conclusions drawn from the study, the implications, and finally, recommendations arising from the findings are given.

1.11 Summary of the chapter

This chapter discussed the general background related to poor conceptualization and underperformance of learners in science in South Africa which have necessitated a review of issues relating to the teaching and learning of science. The following chapter will look at the practical considerations and the theoretical frame work informing this study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The purpose of this chapter is to review the relevant literature as a way to situate the study in the context of ongoing discourse. The first part deals with theoretical considerations i.e. the discourses, issues, and debates that surround the study while the second part deals with the practical consideration i.e. the review of actual empirical studies that have been done, the findings and the conclusions that have been reached. I will also highlight the theoretical framework that underpinned this study.It is my hope that the review would reveal the progress that has been made so far and issues that still warrant further attention.

2.1 Theoretical Considerations

2.1.1 Nature of Science

Science is a discipline that involves the acquisition of knowledge through observation and experiment. This suggests that the teaching of science entails guiding learners to observe, identify assumptions, use critical thinking and make logical conclusions.In this respect,learners' cultural environment assists them in developing a better understanding of science. Consequently, Lederman (1992) has defined the nature of science(NOS)as the values and assumptions inherent in thedevelopment of scientific knowledge. Although, it is generally accepted that NOS must be taught in school, there has been little agreement about the specific aspects of it that should be taught (Alters, 1997; Lederman, 2002; Niaz, 2001; Bartholomew, Osborne & Ratciffe, 2004).

It can be argued that the lack of consensus on the aspects of NOS that should be taught in schools could cause learners to hold invalid views about science and its constituent concepts. Since concepts of science provide the essential meanings of science, it is most probable that learners who hold inconsistent views might equally develop erroneous notions about science, scientific investigations, and scientific reasoning to solve scientific oriented problems. For instance, the way science is taught or presented in the textbooks tends to portray school science as a body of established knowledge that cannot be contested (Millar, 1997). One of the aims of science education, however, is to espouse NOS as a tentative and contestable inquiry (e.g. Lederman, 2002; Ogunniyi, 2006). If what is taught in school differs from what real science is (Ziman, 2000) then learners would hold on to a faulty notion of science and consequently, they would leave school largely scientifically illiterate (Ogunniyi,2006). Saloman (1997) posits that a person is scientifically literate when they have knowledge about science and areable to use such knowledge appropriately. On the other hand, a person can be said to be scientifically literate if he/she has developed valid notions about NOS such as: the tentative and dubitable nature of science; the dynamic nature of the scientific enterprise and the anti-authoritariannotions of science (Ogunniyi, 1999; 2006; Ziman, 2000).

2.1.2 Different Interpretations of Science and Culture

According to Vygotsky (1978),his sociocultural constructivist theory views culture as a metaphorical constraint that provides a useful approach in which to foster intercultural science understanding. A proper understanding of how learners construct their definition of culture, their biases and assumptions, will be of great value in redefining culture and linking it with science.

Iaccarino (2003) asserts that the origin of modernscience can be traced back to the 17th century in Europe with the natural philosophy of Galileo and Newton. The different factors that contribute to its flourishingare: (i) a process that led to the independence of scientific theories, myths, religion and theology; (ii) the interactions among the different European cultures which had a strong influence on *science* and stimulated creativity through the new way of thinking and the new paradigms for the observation of nature;(iii) the foundation of the scientific academies, notably the Academia deiLincei, and the Royal Society which led to scientific progress through the dissemination of new knowledge.

As Eisenhart (2001) posits, in relation to the cultural psychological perpective, culture was defined as the characteristics or the way of life within a social group which are passed down from one generation to the other.According to Seiler(2013),the two limitations of the generally acceptable definition of culture are i) a different view of culture that creates an expectation of differences within a culture, and ii) the homogeneity within each cultureHe added that culture remains fixed and distinct, and that there is a shift in this new conceptualiation; viewing culture as an entity compared to culture as production, where people acquired knowledge and use cultural resources.

Therefore scientific progress requires encouragement and protection of cultural independence. In today's world, science and scientific applications exert a deep influence on the cultural values of society; even the organization of society itself owns too many scientific opinions (The United Nations Educational Scientific and Cultural Organization/The International Council for Science, 1999).

From indigenous knowledge perspectives, according to Ogunniyi (2007a), this is generally regarded as knowledge arising among indigenous people from individual and experience with nature. Unlike Western science, as stated by Mazrui and Ade Ajayi (1998),which is solely based on rational principles, indigenous knowledge is derived from both rational and non-rational processes.

In fact, Western science favours reductionism and mechanistic and quantitative approaches, while indigenous knowledge emphasizes the observation of natural phenomena from a global point of view;but Aikenhead (1996) viewed school science, a subculture of a largely Western culture, as being opposed to indigenous knowledge that subscribes to a largely anthropomorphic worldview.

Many studies by researchers such as Jegede and Okebukola (1991); Aikenhead (1996, 1997); and Ogunniyi (1988, 2011) eloquently argued that the home cultures of learners from non-Western backgrounds play a vital role in the extent to which these learners appropriate science concepts. These studies have shown that science and culture are opposing worldviews, both seeking to explain nature from a different perspective.

The indigenous knowledge, however, acquired from nature, is well planned to be classified as knowledge acquired from science (Western) because there is no actual scientific fact to justify it. Importantly, from a teaching and learning perspective, many studies namely those by Driver, Asoko, Leach, Mortimer and Scolt (1994) and Jehng, Johnson and Anderson (1993) have revealed that the beliefs that learners hold about nature and science exert a great influence on their performance.

Hofer and Pintrich (1997) define epistemological beliefs as individuals' conceptions in relation to the nature of knowledge and the process of knowing it. In this perspective,there seems to be a relatively thin line between Western science and Western culture -probably because Western science evolved largely from the Western culture. Of course, according to Ogunniyi (2005 & 2006), a cursory review of the literature would reveal that the root of Western science also benefitted from non-Western cultures.

It is from these concepts and knowledge of nature and natural elements that Western science was acknowledged and restructured. However, this has had a huge influence, not only on developed countries, but also on the world at large.

2.1.3 Issues around Alternative Conceptions

Conceptions refer to ideas, objects or events that help us appreciate the world around us. According to Martin and his associates,conceptions refer to ideas that give an erroneous understanding of such ideas, object or events that are created, based on a person's understanding (Thompson & Logue, 2006). Learners' alternative frameworks, especially those that are non-scientific, usually form the basis of their undertanding of the world around them. Alternative conceptions formed by learners have a tendency to be resistant to instruction since it entails replacing or fundamentally reorganizing their knowledge (Ferrer, 2013).

Goris and Dyrenfurth (2010) further explain that if an alternative conception is not altered it might persist for years, even to adulthood. Ausubel (1968) holds a constructivist view of learning and believes that learners do not come to the science class with empty minds but have their own existing knowledge about their immediate surroundings.

Different interpretations have been given to learners' previous knowledge by various science education researchers. Some of the views in the literature include naive physics (Vosniadou, 1994),alternative conception (Grayson, 2004; Leite & Afonso, 2000; Tsai & Chou, 2002) and Aristotelian physics (DiSessa, 1982).

However, as many studies in science education have revealed, some of the learners' existing knowledge may serve as a barrier to their conceptualizations of new concepts which they are expected to learn. Having undergone normal learning processes, many learners may still prefer to retain their existing knowledge.

On the other hand, some scholars in the 1980s and 1990s (e.g. DiSessa, 1993; Posner, Strike Hewson & Gertzog, 1982; Slotta, Chi & Joram, 1995) posited that the constant failure to achieve conceptual change among learners as expected through teaching approaches has led to cognitive arguments and propelled some science educators to search for better methods for imparting science more meaningfully.

Learners are naturally curious, but they require assistance in understanding their observations and how to relate the new information to their existing knowledge (Lehr, 2005). When adults encourage children to question, predict, explain, and explore in a safe environment, they should offer them the support that is essential for becoming promising science students and thinkers. Therefore, in teaching the major concepts in science, science educators must give greater priorities to learners'previous ideas.They must first examine learners' previous ideas, identify confusions and then create an occasion for the integration of the previous and new ideas to prevent the erroneous ideas from becoming a barrier to learning.

2.1.4 The Determinant Factors of Alternative Conceptions

Following Wenning's (2008) position, the cause of a given alternative conception is often difficult, if not impossible to determine. In contrast to the later, misunderstanding, miscommunication, and even a misapplication of scientific principles that have been tested and found to be true, can bring about alternative conceptions among learners. It can be argued that sometimes learners can experience the same phenomenon and still draw different conclusions as in the case of demonstrations where there is a lack of critical observation and appropriate follow-up discussion.

Taylor and Dana (2003) provide several examples of students who uncritically interpreted experimental data and ended up with contradictory results. For instance, they point to problems with inappropriate conclusions based on improperly designed experiments, misuse of instruments resulting in unreliable data, overgeneralizations from the data, misinterpretation of graphs, logical fallacies in argumentation, and failure to otherwise apply critical thinking abilities.

These authors also point to the existence of alternative conceptions and their influence on new learning. In other cases, learners might cling to false notions that result from one or more forms of inadequate teaching by their parents, peers, or teachers' false or misleading statements, and inaccurate information about the task given to them.

As noted by Gobet, Lane, Croker, Cheng, Jones, Oliver and Pine (2001) and Ogunniyi, Jegede, Ogawa, Yandila and Oladele (1995), teachers themselves often can be sources of alternative conceptions for their learners.

Several studies such as those by Duit and Treagust (2003),Linder (1993) and Strike and Posner (1982) and Posner, Strike, Hewson and Gertzog (1982) have alsoshown that people tend toconverse with each other as they learn. From a science education perspective, the conceptualchange approach to teaching gives explicit recognition to the importance of prior knowledge. The significance of prior knowledge in learning science as previously reported by Ausbel, Novak and Hanesian (1978) has been widely recognized since 1968 when Ausubel indicated that the most important step in teaching was to ascertain what the learners knew about the subject and to teach them accordingly.

Several studies (Krugly-Smolska, 1995; Lundin, 2008) have reported and demonstrated the importance of prior knowledge and experience in science learning. However, prior knowledge and experiences depend on the culture in which a particular child develops. Serpell (1993) contends that cultures tend to have a significant impact on the behaviour of a developing child. He added that such forces are mediated by the child's mental process and the accumulated resources such as languages, theories, and technologies that exist in the social group in which the child develops.

In other cases, students might misapply the correct information they already possess. A misunderstanding of underlying conditions can lead to what appears to be alternative conceptions. Teachers should be deeply aware that alternative conceptions are not necessarily naive viewpoints. Sometimes they are well-reasoned explanations or over- generalizations that just happen to be incorrect under certain conditions. Therefore educators should not ignore the learners' alternative conceptions but utilize it as a foundation for learners to understand school science (Kambouri & Briggs, 2013).

Posner et al, (1982) stated that the existing ideas acquired by the learners often form the basis of alternative conceptions held by them. From the constructivist perspective, learners donot usually come to class completely void of ideas. Learners acquire from their peers, parents, and the society they live in. Such ideas usually put them between two domains namely, the scientific and everyday world.

Learning becomes more difficult for learners as they try to integrate their existing ideas (i.e. the one they acquired from their everyday domain) with the new ones they encounter in school science.Reif and Lartin (1991) stress furtherthat the differences between school science and the latest scientific ideas propounded by scientists might further compound the learners' notionsof science.

Campbell and Lubben (2000) assert that the difference in the goals and cognitive means for both science and everyday knowledgeare not made explicit enough for students and as a result students tend to unconsciously import alternative conceptions and ways of thinking which are effective for everyday life but not for science.

Learners' reasoning is largely controlled by the experiences that they have accumulated over time and which are inculcated into their cultures' subconscious. For the same reason, learners often find scientific concepts e.g. magnetism, chemical, physical change and the environment (the central focus of this study), to be abstract and foreign but as they attempt to form their own imaginative and conventional conceptual understanding of such terms, they form ones that are far different from the scientific ones.

The teaching and learning of science involvesmany issues involving the teachers, learners, the learning environments, learners' home backgrounds, the school curriculum and numerous others. Therefore, for effective teaching to occur, the teachers must be cognisant of the different alternative conceptions that learners hold, their forms as well as the way they influence the teaching- learning process.

2.2 Learning and Types of Learning

As Hindal, Reid and Badgaish (2009) posit, one of the major reasons why people acquire knowledge is to add value to themselves. Like other valuable things, knowledge is built and rarely revealed if at all,therefore the acquisition of knowledge by learners tends to take place as they learn. An important aspect of science education is the ability of learners to choose from the available knowledge what they consider important for the task at hand and to get rid of what they consider non-essential. Hindal et al. (2009) contend that the ability of the learners to hold on to ideas is essential to the teaching and learning process in science.

As earlier reported by Novak and Godwin (1984), learners who are more curious or divergentare able to take a concept or idea and relate it to various other concepts and ideas, while the more convergent ones tend to bring ideas together to form some form of conclusion that learning after allis personal and distinctive while knowledge acquisition is unrestricted. Numerous scholars, namely Ausubel (1963) and Novak and Godwin (1984) to mention a few, argue that once a leaner's way of acquiring knowledge has been discovered, teaching could then be done in a way that is likely to enhance his/her understanding of what is being taught and therefore become engaged in a purposeful learning endeavour. Ausbel (1963) has highlighted the different kinds of learning to include: i) reception learning; ii) discovery learning; iii) meaningful reception learning; iv) meaningful learning; and v) rote learning.

Following Ausubel 's(1963) position: i) ***reception learning*** does not encourage the sighting of new things,rather, it is taught in such a way that learners are not permitted to participate in the teaching and learning process. He pinpointed that learners are inactive and are at the receiving end. This method is, however, commonly used; ii) ***discovery learning*** is a type of learning which enables learners to discover new things. More so, learners are permitted to participate meaningfully in the learning process. This method is, however, uncommonly used by educators; iii) ***meaningful reception learning*** is a form of learning through which new knowledge is acquired by learners. This process involves new training (i.e. presented to the learners) in such a way that learners have to think about the importance of knowledge and decide how it relates to their previous knowledge and skills; iv) ***meaningful learning*** seems to be similar to *meaningful reception.*

Meaningful learning is a type of learning in which there is a link between the new knowledge and the previous knowledge. The new knowledge learned is fully understood and the learners know how that specific fact learned is related to the previous knowledge of the concept; v) while ***rote learning*** can be referred to as the most ineffective form of learning. The knowledge gained by the learner is stored in such a way that it has very little to do with the learner's active cognitive process.

2.2.1 Learning Strategies and Skills

Mathipa and Mukhari (2014) posit that teaching requires various approaches. The use of an inappropriate method could cause learners to lose interest in their studies,especially science and other science related subjects. These strategies can also be regarded as procedures that are used by learners to achieve their goals. As Karakoç (2004) asserted,learning strategies are clustered around such groups of learning techniques namely attention, rehearsal, elaboration and meta-cognition.

Mayer (2003) defines learning strategies as cognitive processing performed by the learner at the time of learning that is intended to improve the learning. Mayer highlights three categories of learning in terms of: i) mnemonic strategies; ii) structure strategies; and iii) generative strategies. ***Mnemonic strategies*** are techniques used to improve mental retention of facts. ***Structure strategies*** are elaboratiove learning techniques through which the learner creates a mental structure and attaches information presented to the created structure.

Occasionally, according to Mayer (2003), elaboration involves relating new information to the information that was previously in the cognitive structure of the learner. Buxkemper and Hatfield (1995) defined elaboration as the learning techniques used to integrate knowledge presented in a lesson or text with the knowledge already stored in the learner's cognitive structure. ***Generative strategies*** involve integrating presented information with the cognitive structure of the learner. In the same manner. Derry and Murphy (1986) define learning skills as mental tactics used by an individual in a learning situation to facilitate the acquisition of knowledge or ability.

A learning tactic is a more specific skill that one uses in learning (Derry & Murphy, 1986). A group of learning schemes or skills used to facilitate the acquisition of knowledge or skills forms a learning strategy. Mahaye (2001) opined that there is a correlation between teaching methods and learner's achievement level. Therefore, the particular teaching method a teacher employs during teaching has a great influence on learner's learning outcome. Mahaye (2001) also reported that a teaching method is an approach that the teacher uses to facilitate teaching and learning activities in the classroom and also to achieve the desired learning outcome.

A teaching method is a way of carrying out actual teaching in the classroom (Kasambira, 1999). Apparently, there are numerous types of teaching methods that are used for different purposes, which includesi) discovery-learning, ii) lecture, iii) questioning, iv) role-playing, v) story telling and so on. According to Petty (2009a & 2009b), the approach of the teacher in lesson presentation,however, determines the learning outcomes. In addition, if a teacher employs effective teaching methods for particular learners during lesson presentation,the learners will actually learn effectively.

On the otherhand, if a teacher uses inappropriate teaching methods,the desired learning outcome will not be achieved. Following a critical literature review, it has been revealed that amongthe numerous types the of teaching approaches available, ***constructivism*** has been found to be one of the most effective teaching and learning methods; the reason is, according to Moore (2009), is that it encourages cooperative learners who otherwise would have felt threatened if confronted with the task alone.

Floden and Prawat (1994) argue that according to the constructivism learning theory, knowledge is actively constructed by learners. In personal constructivism, Powell and Kalina (2009) posit that learners manage to construct ideas by using their own critical thinking while in social constructivism, ideas are constructed through the interaction between the teacher and the learners.

Moore (2009) stresses that cooperative learning and scaffolding are some of the significant teaching methods used in the constructivist approach. Mills (2009) posits that teaching meaningfully often takes time and a lot of preparation.Thus, learning to teach effectively is often a challenging experience.

As Mills (2009)asserts, teachers with more teaching experience tend to be more effective than a teacher with less teaching experience. In addition, experienced teachers tend to teach their learners expertly while their learners are always kept engaged in learning a task by hearing, seeing, touching, discussing in pairs and so on.

Following Petty's (2009a) arguments, the only way to improve teaching is to change it consistently in order to achieve better learning outcomes. For learners' needs to be met in the classroom, teachers need to use various teaching methods in their lesson presentation (Killen, 2010).In this context, learners are encouraged to participate meaningfully in the lesson, thereby enhancing their understanding. According to Killen's (2010) position, a teacher needs to use a number of different teaching methods during the same lesson so that the learners' needs can be met. As Cruickshank, Jenkins and Metcalf (2009) suggested, teachers' beliefs about themselves, their learners and what they teach, have an influence on the learning process.

Importantly, teachers have the tendency to believe that teaching and managing high-ability learners is easier but slow learners are incapable of improving their academic performance. As Lindeque (2001) asserts,some teachers have negative or positive attitudes towards some of their learners and stereotype them as gifted or slow learners.

Posner etal.'s (1982) model of teaching for conceptual change forms the basis forthe general conclusion from the literature that learners' previous knowledge is difficult to change, especially when learners are given unfamiliar tasks or information that contradicts their beliefs (Linder, 1993; Chinn & Brewer 1993; Vosniadou & Brewer, 1994).This study reviewed how difficult it is for learners to change their existing knowledge due to the ineffectiveness of conceptual change approaches.These are based on creating cognitive conflict to force learners to abandontheir previous conceptions.Many science educators have also expressed dissatisfaction with such teaching approaches.

2.2.2 Assessment of Teaching and Learning

Assessment in formal education is inevitable. It is impossible to visualize formal education that is not punctuated by assessment events designed to check the effectiveness of what learners have been taught (Broadfoot& Black, 2004). Popham (1999) asserts that assessment is an attempt by classroom teachers to ascertain the status of students' knowledge (cognitive understandings abilities), as well as skills and attitudes (psychomotor and affective factors).

Through assessment, thestrength and weakness of the learners can easily be ascertained (Broadfoot, 1996). Ogunniyi (1984) also argues that assessment deals with the evaluation of value or the estimated worth of a thing, or programmes in order to arrive at a meaningful conclusionabout the quality of that programme.

Educational assessment is the process involving the collection and analysis of information in order to draw a conclusion about learners' learning and attainment in relation to curriculum outcomes and goals. Thus, assessment is a crucial factor in the teaching and learning processes (Gipps & Stobart 2003; Shepard, 2000).The two most common forms of assessment are formative and summative assessments.

Summative Assessment

Formative assessment is carried out during the teaching-learning process throughout the year while summative is normally carried out periodically e.g. at the end of a unit, term, semester or academic year in other to produce a summary of students' overall performance. This summary forms the basis for judging to what extent students have achieved the curriculum goals. The summary is also useful for comparing each student's achievement with that of other students and in the preparation of students' reports for parents, administration, inspectors and other interested agencies.

The reason why educational assessment is carried out from time to time also includes the following: (1) to make a reliable decision about educational planning; (2) to encourage or motivate learners to put in more effort into their studies; (3) to show progress made in the curriculum implementation; (4) to encourage or to motivate the learners to develop a sense of discipline and systematic study habits; (5) to identify an area where learners have difficulties; and (6) in making a crucial decision concerning learners' education (Ogunniyi, 1984). Biggs (1996) asserts that there is a close connection between assessment and learning. He explains that learning is driven by assessment, making it vital that high-level assessment tasks are set that truly reflect the overall aim of the institutional and particular course objective (Biggs, 1996).

Formative Assessment

Formative assessment has been described by several scholars in different ways. Black and William(1998b) state that there is no tight definition or internationally agreed upon and widely held meaning for formative assessment. They further noted that formative assessment can refer to all activities undertaken by teachers and or their learners that provide information to be used as feedback to modify teaching activities in their classroom and to meet learners' needs. Elliot, Kratochwill, Cook and Travers (2000) have highlighted the fact that teachers use assessment information to evaluate the effectiveness or otherwise of their teaching strategies,the level of attainment of curriculum goals and how to help learners achieve instructional objectives.

The different ways in which formative assessment information is used as indicated above, link assessment to classroom instruction and learning in ways that are encouraged through new assessment techniques. Another way of linking formative assessment to classroom instruction is through feedback from teachers to students on their learning progress. Feedback received by students regarding their learning comes in the form of marks or grades, comments and endorsements of their work.

Elliot et al. (2000) opined that such feedback enables learners to be aware of their level of achievement; areas where they need to make necessary corrections and also offers them the opportunity to set goals and academic expectations for themselves. Thus, learners are expected to act on feedback from assessment activities to improve their understanding of subject matter and performance in their studies (Stepanek, 2002).

Formative assessment supports learning through feedback and students' positive reaction to such feedback. Gipps (1994) extends the use of assessment from support for learning through feedback to using assessment to enhance learners' competencies. She further advocates for an alternative way of viewing classroom assessment. She acknowledges that assessment is undergoing a typical shift from a psychometric and measurement perspective to an assessment view. In this view, students are active participants in the assessment process. Assessment helps students to learn and teachers to improve teaching. In this view the functions of assessment extend beyond assessment of learning to assessment of learning and skills development (Gipps, 1994).

Assessment of learning emphasizes what learners have learned while the activities used in assessment for learning are designed to facilitate the development and consolidation of learners' knowledge and skills (Gipps & Stobart, 2003; Shepard, 2000; Wiggins, 1996/1997). Such a view requires assessment to be an on-going process so that it continuously informs the management of learning by both learners and teachers (Taber, 2003).

The use of assessment instruments such as tests and examinations papers for summative and formative assessment, may overlap. William and Black (1996) have contended that an assessment instrument initially designed for summative functions may be used informatively to help students prepare for further summative tasks. This can be observed when teachers instruct the learners to go through past examination papers in preparation for future nationwide examinations. In some instances the results from tasks and exercises intended for formative assessment may also be used to measure students' achievement in summative ways (Kelly, 2007).

Assessment in formal education is inevitable. It is impossible to visualize formal education that is not punctuated by assessment events designed to check the effectiveness of what learners have been taught (Broadfoot & Black, 2004). Popham (1999) asserted that assessment is an attempt by classroom teachers to ascertain the status of students' knowledge (cognitive understandings abilities) as well as skills and attitudes (psychomotor and affective factors).Through assessment, strength and weakness of the learners,as well as the functioning of the educational institution,can be ascertained (Broadfoot, 1996). Ogunniyi (1984) also argued that assessment deals with the evaluation of value or the estimated worth of a thing, or program in order to arrive at a meaningful conclusion.

Educational assessment is the process of collection and analyzing information in order to draw a conclusion about learners' learning and attainment in relation to curriculum outcomes and goals. Thus, assessment is a crucial factor in teaching and learning processes (Gipps & Stobart 2003; Shepard, 2000).The two forms of assessment are formative and summative assessments.

2.3 Socio-Cultural Constructivism

The socio-cultural theory is a theory of knowledge which stresses that social interaction plays a fundamental role in the development of cognition. Current conceptualization of social cultural theory is based on Vygotsky (1986) as well as other theorists such as Wretch (1991).

Vygotsky opined that the roles of learners' environments, the people that they react with including culture, in shaping their beliefs and perceptions, cannot be overemphasized as they develop. In addition, a child's holistic development cannot be assumed through a study of the individual, but rather by considering the environment in which that individual has been brought up. Learning is also defined by Vygotsky as one that cannot be alienated from social happenings as they occur when children relate to objects, people, and other immediate environments.

A major feature of this view of human development is that higher order functions develop as people communicate and relate to each other. Moreover, Sutherland, Armstrong, Barnes, and Brawn (2004) stress that the exceptional thing about the socio-cultural theory is the fact that certain devices or tools mediate human actions or learning.

In other words, the theory places emphasis on social interactions enacted by humans in a social setting e.g. interactions such as those happening in the classrooms between teachers and learners happen in a social setting predisposed by universal and national factors such as the curriculum.

Opposing the concept of tabularasa, the socio-cultural theory identifies the various learner experiences brought to the classroom, deriving both from social interactions (outside the classroom) and class interaction. Tharp and Gallimore (1988) opined that the socio-cultural perspective has thoughtful implications for teaching, schooling, and education, especially in language teaching and learning. Its strength lies in the fact that it identifies the role of social interactions as individuals build knowledge and negotiate meaning in real world situations while acquiring language skills (Lantolf & Thorne, 2007). This implies that one must also examine the external social world within which that individual has been brought up, and through participation in the lived experiences of a particular social setup.

According to Lim (2002a), Vygotsky's socio-cultural theory is ideal for learning because it has many concepts that can be applied in many other learning institutions, particularly, conjoining cognition with activities. This is particularly because higher mental functions are thought to be experienced on two planes, namely the social and psychological (Lim, 2002a).

The social plane is referred to as the inter-psychological class happening between people while the other is an intra-psychological happening within an individual learner. Lim (2002a) highlights the fact that human mental functions as claimed by Vygotsky are mediated by culturally embedded tools, both technical and psychological**.**

Vygotsky, the pioneer of socio-cultural theory, also developed two theories: the Zone of Proximal Development (ZPD) and the More Knowledgeable Other (MKO). These theories were developed based on his theory of social constructivism. He stresses that learning is continual movement from the current intellectual level to a higher potential intellectual level. Every function in a child‘s growth appears twice: i) on the social level and later, ii) on the individual level: between people (inter-psychological) and then inside the child (intra-psychological). This applies to voluntary attention to logical memory, and to the creation of concepts.

All other functions originate as an actual relationship between individuals (Vygotsky, 1978).Vygotsky was motivated to develop the theory, the Zone of Proximal Development to consider that when a child continues to learn from an adult, it will reach a stage whereby he/ she would be able to do the task independently. ZPD has been defined as the distance between the actual development level as determined by independent problem solving, and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978).

Vygotsky opined that the necessary assistance giving to a learner within the ZPD for a particular task will go a long way in helping the child to accomplish the task. And once the learner has fully mastered the task, the assistance given may be withdrawn and the learner will be able to do the work independently. The MKO is considered to be a more knowledgeable person than the learner;it can be a teacher or peer who is more knowledgeable than the learner on the relevant subject matter.

2.3.1 Constructivism in Teaching and Learning Science

Several studies on teaching and learning of science have acknowledged constructivism as an influential approach for developing scientific literacy (Matthews, 1997; Richardson, 1997; Tytler, 2002). Constructivist approaches to science teaching are analogous to the science that scientists engage in,in that they are inquiry-based and offer science teachers the opportunity to fulfil the constructivist promise of improved teaching and learning (Hausfather, 2001; Lorsbach & Tobin, 1998; Tam, 1999).

Hausfather (2001) claims that constructivist epistemology encourages teachers to make sense of what they see, think, and do in facilitating learners' learning. Tobin and Dawson (1992) claim that in a constructivist classroom, teachers recognize that the learners' prior knowledge that they bring to the learning environment is important and will strive to scaffold learning so that it clashes with that prior knowledge. Therefore, constructivist teachers are facilitators of learning rather than transmitters of knowledge (Chaille & Britain, 1991).

A major criticism of the constructivist approach is that it requires more time for exploring and negotiating an understanding with learners (Tytler, 2002). Taylor, Dawson and Fraser (1995) further stress that in a constructivist-learning environment: learners are given the opportunity to communicate their understandings with other learners, to generate plausible explanations for phenomena, to test, evaluate and defend their explanations among their peers, and actively engage in the social construction of knowledge, all of which are reflections of the science. They are also provided with frequent opportunities to identify their own learning goals, to share control of the learning environment, and to develop and employ assessment criteria within the learning environment.

However, as Jenkins (2000) has pointed out, the notion of active or passive learning is rather equivocal in that it required some form of active intellectual engagement in relation to what is to be learned. Despite the validity of Jenkins's contention, it is still helpful to explore some of the insights that constructivism has provided about how science can be taught or learned in a meaningful way.

Ausubel posits that constructivism is a theory that contracted meaningful learning from route learning. Ausubel's idea of meaningful learning suggests that in order to learn meaningfully, learners must relate the new knowledge to their previous knowledge. His theory reaffirms the important role played by existing knowledge in learning new things as well as the active role played by the learner as he or she tries to link new material to the idea they have (Ausubel, 1968).

Piaget's theory of constructivism stresses that mental schemes are used by both the children and the adult to guide cognition and interpret new ideas in relation to previous schemes. Piaget also suggests that the process of altering the previous schemes is referred to as accommodation (Piaget, 1978). Bodner (1986) analyses Piaget's theory of knowledge creation and forwarded two key concepts, namely assimilation, and accommodation. Assimilation is the process whereby a new experience clashes with the old one.

In a condition whereby learner's old schemes do not fits into the new information, the formal schemes must be altered or a new one made to enable the translation of information. Taylor et al.(1995) eloquently argue that learning is a social process and that new meaning is negotiated. For this reason, many researchers now use the term social constructivism to emphasize the social dimension of learning. From this perspective, this study contends that in teaching and learning, socio-cultural critical constructivism theory plays a major role in the conceptualization of concepts in science, thereby making the teaching and learning of science effective.

2.3.2 Constructivism as a Theory of Learning

Constructivism, as a theory of learning, stipulates that knowledge is a human construction. Jenkins (2001) maintains that a central characteristic of Constructivism is the idea that the development of understanding requires active engagement on the part of the learner. To Jenkins's theory, active engagement must be added.

A constructivist view of learning suggests that learners construct knowledge by interpreting experience in terms of previous knowledge. As Tsai (2002) asserts, peoples' subsequent actions and thoughts are constructed from their earlier ideas. Cobern, cited in Tobin (2002), draws an analogy between the constructivist approaches to learning and a construction site. Just as new structures are built on existing foundations at the construction site, new learning is constructed on the foundation of prior learning and experiences.

In the constructivist perspective, learning takes place when students use their prior learning to interpret and make sense of their surroundings (Tobin, 2002). As they interact with their teachers, peers, and instructional materials, students in primary and high school construct knowledge. The knowledge that students construct falls into two categories: knowledge about individual objects of inquiry in science lessons and knowledge about the science learning enterprise itself. Knowledge about the learning enterprise includes meta-cognition. Meta-cognition, as indicated previously, is knowledge, awareness, and control of one's own learning (Gunstone, 1994).

2.3.4 Constructivism as a Theory of Knowledge

As a theory of knowledge,Constructivism is concerned with the nature of knowledge and what it means to know (Schwandt, 1994). Von Glasersfeld (1991) argues that knowledge in traditional epistemology is said to be true if it is considered to exist prior to and independent of the knower's experience of it. Constructivism in its radical form rejects the idea that the validity of knowledge claims lies in the correspondence between the knowledge claim and an independently existing world. Constructivists maintain that the world can only be understood, from individually unique perspectives that are constructed through experimental activity in a social and physical world (Derry, 1992).

A knowledge claim in the constructivist paradigm is valid if it works to achieve a goal. The inference here is that individual’s viewpoints should be assessed on the condition of achieving a stated goal. The knowledge produced in the course of this study is not a reflection of some reality that exists, independent of the author. It is a representation of some hypothetical reality that is consistent with the data collected. The validity of knowledge claims made in the study is to be judged by their usefulness in promoting understanding of the poor performance in science, problems among scholars in science education and by the self-consistency of the findings of the study in relation to findings of other related studies.

2.3.5 Learners' Socio-Cultural Background

Campbell and Lubeen (2000) assert that for meaningful learning to take place, proper attention must be given to their existing knowledge. They further opined that their socio-cultural background is part of the existing knowledge that serves as the main source for indigenous knowledge in science. According to Chiappetta, Koballa and Collette (1998), culturally diverse students develop meaningful science understanding when they see their culture facilitating learning, rather than being a barrier to it.

Sutherland and Dennick (2002) opined that the language of communication in the learners' environment, namely their first or home language, will be of great help to them in communicating background knowledge that they bring into the classroom.

According to Fakudze and Rollnick:

The knowledge systems of indigenous communities are grounded in oral traditions that use mythology and legends rather than the Newtonian-Cartesian epistemologies of European culture. This knowledge formation has a direct bearing on the languages of these indigenous people in the sense that the terminology is embedded in cultural taboos and euphemism. The terms used do not have univocity as in Western cultures, where a single term would have one concept. Because of these language issues and other factors, first language (L1) students from these cultures have difficulty in accessing school science that is taught in English and based mainly on a Western worldview (Fakudze & Rollnick, 2008, p.3).

As explicated by Fakudze and Rollnick (2008), learners' background language explains occurrence using different epistemological beliefs. Learners often have a problem in understanding what school science is saying since the direct translation from the home language will not give an accurate meaning. For Africa learners to be properly educated, proper cognizance must be given to their background language from which their indigenous knowledge derives.

2.4 Meaning of Conceptual Understanding

According to Krugly-Smolska (1995); Mayer (2002); Llewellyn (2005); Liang and Gabel (2005) and Lantolf and Poehner's (2008) position, conceptual understanding is the appropriate ability to make use of the knowledge learnt or gained from a concept.

As Posner et al. (1982) argues,for learners to assimilate a new concept that is completely different from the ones they hold, certain conditions must be met which include the following: i) the learners must accept the inadequacy of their existing knowledge on a subject. This is easily revealed when they are engaged in tasks in which they demonstrate indequate understanding based on existing knowledge; ii) the new knowledge should be understandable to the learners; iii) the new knowledge must be plausible at the outset. This means that it should appear more consistent in solving atypical situation that would make them lose confidence in their existing knowledge; and iv) the new knowledge should have the ability to produce a new basis for further studies.

2.4.1 Conceptual Understanding and Age

The significance of age-related differences in the performance of learners has been reviewed by several studies within certain groups or classes of learners; relatively younger learners display a different performance with respect to relatively older learners. In a wide array of cognitive and academics outcomes, the oldest learners in a given class or academic group typically outperform their youngest mate (Bedard & Dhuey, 2006; Crawford, Dearden & Meghir, 2007).

Newman et al. (2009) reported that older students are considered to be short of fundamental skills required for effective study or are impaired by age-related intellectual deficits. Older students tend to be admitted into school with distinctly lower educational attainment than the young students. Crosser (1991) as well as La Paro and Pianta (2000) opined that older learners are usually outperformed by their younger age appropriate age group.

Uphoff and Gilmore (1985), in their studies about the relationship between age and achievement, also argue that the older and more mature learners in a class perform better than the younger ones.

The medical and psychological literature documents that, just like physical strength, cognitive abilities first develop and then deplete with age, with the turning point for the average person being probably in the early twenties (Jones 2010; Salthouse, Schroeder & Ferrer, 2004).In the early stage of childhood development, the implication of more maturity seen in the older learners probably gives them an upper hand in their performance by dominating the benefit of learning. As children grow older, such an advantage fades out and possibly reverses, thus giving rise to better performance by younger learners (Pellizzari & Billari, 2012).

Several studies have also shown that starting school earlier is associated with a better long-term result (Fredriksson & Ockert, 2005; Goodman & Sianesi, 2005; Skirbekk, 2005; Skirbekk, Kohler & Prskawetz, 2004; Black, Devereinx & Salvanes, 2009). Cunha and Heckman (2007, 2010) have argued that early investment in skills improves the return on later human capital investments. Younger students are advantaged through early learning, either at school or home.

The youngest learners in a group develop important personality traits and social skills such as self-esteem and leadership, to a lower extent or at a lower pace compared with their oldest mates. In a simple model of efficient time or effort allocation, these psychological effects lead to lower returns on social activities for relatively younger learners, who then devote more time to their studies, outperforming the oldest learners (Thompson, Barnsley & Battle, 2004; Persico, Postlewaite & Silver, 2004; Dhuey & Lipscomb, 2008).

Many researchers also contended that it is untrue that learners who are at the same age or grade level are necessarily at the same cognitive level (Aikenhead, 1996; Kelly, Carlsen & Cunningham, 1993; Ogunniyi et al., 1995).

2.4.2 Conceptual Understanding and Gender

Human beings are endowed with different characteristics biologically, physically, mentally and behaviourally. The range of these characteristics between a male and the female can be referred to as gender.

For decades, the relationship between gender and the academic achievement of learners has been an area of concern to many researchers (Eitle, 2005). In science education, several research studies have reviewed, gender as one of the factors that influence the performance of learners (Eitle, 2005; Haist, Wilson, Elem, Blue & Fosson, 2000; Chambers & Schreiber 2004; Newman-Ford, Lloyd & Thomas, 2009). Ede (2004) states that gender needs to be considered as it plays a vital role in learners' performance, right from their early stagesof life.

A gap between the achievement of boys and girls has been found, with girls showing better performance than the boys in certain instances (Chambers & Schreiber, 2004). The differences in the performance of boys and girls in standard science tests seems to decline with time (Kerr & Kurpius, 2004; Demie, 2001; Parker, Rennie & Harding, 1995).

Newman-Ford et al.(2009) claim that gender has only a minor impact on academic achievement. It is important to point out that gender differences do exist, depending on the subject matter (Haist et al., 2000). Hartley and Sutton (2013) have recently opined that boys tend to display superior academic development with regards to motivation ability, performance, and self-regulation.

Coley (2001) opined that females score higher than males in reading and writing across all ethnic age groups. Hedges and Newell (1995) assert that gender differences generally are small or non-existent and that in science, boys outperform girls, but in reading and writing, girls have the advantage.

Haist et al.(2000) posit that men perform better than women in certain settings while women outperform men in other settings. Zohar and Bronshtein (2005) demonstrate that having fewer females studying physics limits the number of females that can eventually undertake scientific careers at several universities; thus maintaining the status quo of gender inequality in scientific professions. They further point out that fewer female physics students add to the problem of fewer physics students in general.

Okeke (2003) argues that when females choose not to study physics in high school, it leads to smaller numbers in general, that are available to become scientific professionals. But Woodfield and Earl-Novell (2006) stressed that female students outperformed male students and this can be attributed to their being more hard-working and their regular attendance in class. On the other hand, Borde (1998) asserts that academic performance is not influenced by gender in any case.

2.4.3 Conceptual Understanding and Language

As previously reported by Probyn (2006), learners in South Africa learn science at school in a language medium (English), which is not their own home language;this has resulted in learning challenges. Msimanga, Denley and Gumede (2017) added that one of the reasons for the persistent poor performance of learners in science is language. Alexander (2002) has further argued that the insistence of teaching in English and neglecting the learners' prior language, will result in the diminishment of their cognitive understanding of English high status domains, such as science and mathematics. Giving attention to English and neglecting the learners' home language, also results in the loading of learners with concepts that they cannot relate to. The only alternative the learners will have, is to store the information through memorisation, hence rote learning is developed.

The Trends in Mathematics and Science Study (TIMSS) indicates a correlation between lower achievement levels in science and home language which is different to school language.Van der Poll and Van der Poll (2007) argue that when learners are required to learn content in a second language, they are usually faced with problem of content literacy; the mastering of the content of the subject becomes very difficult therefore the learners' performance is affected. It is generally believed that the language of instruction used in the teaching and learning of science has a great impact on the conceptual understanding of the learners.

According to French (2004), the language that teachers use during their interactions with children has the potential to structure the concepts they are teaching as well as children's understanding of the concepts. Worth, Moriarty and Winokur (2004) contend that children should be encouraged to discuss their thoughts, reasoning and observations as part of activities and play.Thus teachers should assist children in developing not only their ability to use language, but also their communication skills and cognizance of their thoughts.

As Bond and Wasik (2009) stated, educators who ask learners open-ended questions should provide them with the opportunity to engage in conversations, that allow them to use language in meaningful ways as South Africa learners' conceptual understanding is negatively affected by the same factor of language of instruction.

Mostly, they find it difficult to understand concepts in science and this resulted in poor performance in the subject. If learner's access to science, according to Howie, Scherman and Venter (2008), is denied through inadequate communication and comprehensive skills, then poor conceptual understanding is inevitable and has dreadful consequences. Muralidhar (1991) and Msimang (1992) also stated that in science education, language can be perceived as a tool that facilitates communication between the teacher and the learners in a science classroom.

2.4.4 Code Switching

In science education today, some of the factors that are causing the teaching and learning of science to be ineffective can be attributed to thelanguage of instruction. Science teaching and learning occurs almost absolutely through the medium of the spoken and written language.

As reported by Rollinick and Rutherford (1996), home language is an important tool that learners can use to explore their ideas. They added that without the use of code switching, some learners' alternative conceptions would remain unexposed. Hence switching between two languages while teaching in order to enhance learners' understanding of concepts, and ideas, and proper communication of these ideas, can be referred to as code switching.

The importance of home language cannot be over-emphasized, as it serves as a mediator of thought. The teacher and the learners switch between thehome language and the instructional language. For instance,learners often conceal their misconceptions, which are likely to be unfolded among their peers,parents and other family members while interacting with each other in their own home language. Apparently, this has become a common phenomenon among learners and a barrier to their conceptualization in general. Advisably, it is very important for the teacher to be more sensitive while teaching, to observe the learners and know exactly when to switch code (i.e. between the home language and the instructional language).

2.5 Empirical Studies on Scientific Concepts.

In science education today, several studies have extensively investigated learners' understanding of scientific concepts, their interests in science and the effect of age and gender on their performance. The following is a synopsis of these studies.

Pellizzarri and Billari (2012) in their study of age-related differences in academic performance among learners of different ages within the same cohorts using a database of students at Bocconi University, revealed that the youngest learners outperform the oldest learners. They used identification strategies that took into consideration the potential endogeneny of age at school entry by means of an instrumental varriable based on the availability of private pre-schools in the learners' province of birth. Their findings are only partly explained by differences in cognitive ability and rather seem to be associated with differences in their behaviour.This is contrary to this study.

This study tends to look fully into the cognitive ability of the learners by exploring their conceptions of the three scientific concepts: magnetism, chemical change of substances and the environment.This study also looked at the effect of their age, gender and language on their performance. Furthermore,based on the findings and the conclusion of their study and the recommendaton that they made among others, that parents and society should elimilate fears in all students, especially females students towards the study of mathemathetics, science and ICT related courses, suggests that the impact of society or the environment of a learner on cognitive skills developments, cannot be underestimated. Hence this is in line with the theory: sociol–cultural constuctivism, that underpinned this study.

Weaver-Hightower (2003) stated that in olden times, greater priority was given to boy's education over girls, this in turn gives boys a lot of opportunities and encouragement to outperform girls academically. In the same vein, Hartley and Sutton (2013), in their studies : A stereotypical threat account of boys' academic under achievement stystematically examined the age at which children develop stereotypes surroundings boys, under achivement at school and how it can be corrected, examined learners in year three (seven to eight year olds), since by this age they have developed the meta cognitive abilities needed to be influenced, in order to manipulate the stereotypical threat informing them. A total number of 162 British learners (80 boys and 82 girls) from three primary schools in England participated in the study.Their finding revealed that boys tend to do worse than girls at school.

Legewie and DiPrete (2012) in their study, used a quasi experimental research design to explore the gender gap in educational achievement among grade 5 learners in Berlin.They investigated the gender differences in the causal effects of peer socio-economic status (SES) as important school resources on test scores.Their finding provided strong evidence that boys are more sensitive than girls to the important school resources of classroom SES composition and also broadened our understanding of the well established fact of boys' underperformance .

Though in their study, the theoretical argument applies to all kind of school resources that created a learning-oriented environment; however their emprical analysis only focuses on one dimension, peer socioecomic composition. Considering this limitation, there is a need for future studies in order to establish the extent to which conclusions from this study apply to other kind of school based resources.

Lyons (2006) study explored the decisions of high school learners on taking physics and chemistry courses in Australia.The sample of the study included 196 year 10 students(15-16 years) from six high schools in urban and rural New South Wales, Australia.The study used a multiple framework to explore the different background charactristics that several studies had shown were implicated in the learners'choices of studying science. Questionnaire and data were used to gain information from the learners. Based on the analysis, the study found that the learners'decisions involved the complex negotiation of a number of cultural characteristics within their school science and environment or family worlds. Furthermore, he reported that learners regarded junior science as irrelevant, uninteresting and difficult, leading them to see no reason for enrolling in senior science courses. He finally concluded that the low instrinsic value of science has a great impact on the decision of the learners not to chose physical science courses in senior school.

In the same regard, Lindahl (2007), in her study on students' attitudes towards science and choice of career with 70 Swedish learners from grade 5 (age 12 years) to grade 9 (age 16 years), revealed that learners' career aspirations and interest in science were largely formed by the age of 13 years. In addition, Lindahl concluded that engaging older children in science would be more and more difficult.

The Scientific and Technology Literacy Project (STLP), based at the University of the Western Cape, carried out a series of assessments to determine the problems encountered by South African Primary and Secondary school learners in science and to implement necessary instructional strategies to solve such problems. (Ogunniyi, 1999) revealed that female students usually outperformed the male students.

A study was carried out by George (2014) on the Effects of Dialogical Argumentation Instruction on grade 10 learners' understanding of concepts of chemical equations in a High

School in the Western Cape Province South African. A survey questionnaire, open-end and fixed choice questionnaires and a chemistry achievement test, were used to collect data. The findings revealed that the girls performed better than the boys although the difference between their mean scores is not statistically significant. Also, the examination-orientated curriculum made it difficult to do enrichment and expanded activities. Some of the teachers were skeptical of the alternative instructional method and therefore were cautious about taking part in the study. The fact that the experimental and control group were at the same school, could cause contamination of data when participants interact and exchange information.

Mpofu (2006) conducted a study in South Africa which focused on 121 grade 12 students' conceptual understanding of chemical reactions dealing with fluoridation. The study revealed that in most cases the students guessed or just filled in the blank spaces. They did not seem to bother about whether their responses were right or wrong. With further inquiry about their poor performance on these items, it became clear that the students were not adequately introduced to the topic in grade 10.

Futhermore, Ogunniyi and Taale (2004) studied the relative effects of remedial instruction on 49 grade seven learners' conceptions of heat, magnetism, and electricity. The aim of the study was to determine the conception of grade seven learners' conceptions of heat, heat transfer and electricity and the effects of a remedial instructional strategy in ameliorating the alternative conceptions they associated with such concepts. Using three instruments: the Science Achievement Test (SAT), an interview and the classroom observation schedule (COS), they found that a considerable percentage of the learners experienced difficulties with the concepts of heat and heat transfer, magnetism, and electricity, largely because of the subjects'poor language deficiency in English. Their finding, contrary to the conceptual change theory (Posner et al., 1982), did not reveal any evidence that their subjects ever became discontented with their own worldview in favour of the scientific worldview.

Ogunniyi and Mikalsen (2004) also conducted a study on the ideas and process skills used by South African and Norwegian students to perform cognitive tasks on acid bases and magnetism. The purpose of their study was to determine thestudents' ideas about acid bases and magnetism and the process skills used to perform the tasks. The study involved the use of two assessments instruments namely: My Idea about Acids and Bases (MIAB) and My Ideas about Magnetism (MIM). The study employed a quantitative method with two small stratified samples consisting of 15 schools in the Western Cape and four schools in Bergen Municipal with a sample of 130 South Africa and 121 Norwegian students.

Their findings revealed that there were problems with what the learners had been taught or learned about acids, bases, and magnetism. They concluded that although the two groups of students might be familiar with the content of the MIAB and MIM, and held some valid ideas about acids, bases and magnetism, they were not always able to: i) mobilise the necessary conceptual process of decision making; ii) utilize process skills in performing a number of cognitive tasks; and iii) demonstrate the knowledge and skills called for in a consistent manner despite the fact that they were formally instructed.

Rollinick and Rutherford (1996) carried out a study on the use of mother tongue and English in learning and expression of science concepts. The study involved groups of primary teacher trainees in Swaziland. They used four different combinations of language usage and teaching strategies. The audiotapes of the group work of the participants were analyzed using both English and SiSwati and its effect on conceptual change and frequency of languages changes and social interaction of the group during learning. Their findings revealed that home language is an important tool that learners use to explore their ideas and to eliminate alternative conceptions.

Conclusion

Based on the foregoing theoretical consideration of scholarly opinions, the researcher suggests that learners' conceptual undertanding is influenced by certain socio-cultural factors such as sex, age, language attitudes and socio-economic background. While the extant theoretical literature attests to the influence of these factors on learners' conceptual understanding generally, it is difficult to identify which factors exert greater or lesser intellectual force on their conceptual development.

A copius review of the literature namely Ogunniyi (1992) and Aikenhead (1996); Kelly, Carlsen and Cunningham (1993);Ogunniyi et al. (1995);Grissom (2004); Dhuey and Lipscomb (2008) have not really provided a clear picture of which variables e.g. school environment, teachers' knowledge and instructional skills, peer influence, class size and so on have the most influenceon learners' conceptual development in science. For instance, while some reseachers are of the view that gender, age and socio-economic background of learners are most critical, others feel that learners' alternative conceptions, availability of learning resources and instructional methods, are the most critical.

In view of these inconclusive arguments, it seems apposite to consider actual empirical studies literature, in order to fully determine to what extent the claims made by scholars are justifiable. For this study, I hoped that an exploration of both theoretical and empirical literature, otherwise known as practical consideration, might provide a more robust picture of issues surrounding learners' conceptual understanding than would otherwise have been the case.

Learner's holistic development cannot be assumed through a study of the individual, but rather by considering the environment in which that individual has been brought up. The exceptional thing about these studies, is the fact that certain devices or tools mediate human actions or learning. In other words, the studies place emphasis on social interactions enacted by humans in a social setting, e.g. interactions such as those happening in the classrooms between teachers and learners, and those that happen in a social setting predisposed by universal and national factors, such as the curriculum.

However, the implication of these is that in opposing the concept of tabularasa, socio-cultural studies identified the various learner experiences brought to the classroom, derived both from social interactions (i.e. outside the classroom) and class interaction.

The conflict between how an individual understands scientific concepts or phenomena may result in misconceptions, poor performance in sciences and other science related subjects. A number of available studies have focused on the FET phase. Very little literature has studied Senior Phase (Grade 8 and 9) learners'conceptions of scientific concepts, which is the focus of this research. It is against this background that this study has been conducted with the hope that the study would reveal the issues still warranting further attention.

On the other hand , in view of the nature of the study and the constraints of access by the Western Cape Department of Education (WCED) to schools beyond the normal schedule for researchers to go into schools for data collection, only the following aspects,namely, the learners'conceptions of scientific concepts,conceptions held by the learners as evidenced in their use of appropriate scientifc vocabulary, conceptions that the learners hold in science comprehension, and conceptions that the learners held relative to the identification of scientific diagrams or pictures, could be addressed in this study.

2.5 Summary

This chapter has provided a critical literature review on theoretical and empirical considerations.The important issues and debate surrounding the study, which are necessary to help the researcher and the readers develop a thorough understanding of and full insight into previous research relating to the practical considerations and objectives of this study, are discussed. Numerous scholars such as Ogunniyi (1992); Aikenhead (1996); Kelly, Carlsen and Cunningham (1993); Ogunniyi et al. (1995); Grissom (2004), Haist et al. (2000); Chambers and Schreiber (2004); and Eitle (2005) as well as Dhuey and Lipscomb (2008) and Newman-Ford et al. (2009) have emphasised the conflicting and inconclusive nature of their findings.They contend that gender, age, language, socio-economic background and attitudes of learners are critical to their understanding of certain scientific concepts; they claim further that learners' conceptual understanding depends on the subject matter and thus, is largely influenced by the teaching methods used, while Borde (1998) and Okeke (2003) as well as Woodfield and Earl-Novell (2006), claim the opposite.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction.

This research work aimed at investigating Western Cape Senior Phase (8 and 9) learners' conceptions of magnetism, chemical change of substances and the environment. This chapter presents the methods and procedures used in the course of this study. Specifically, it describes the research setting, sample and design of the study. The chapter also presents the procedures used in developing the instruments for data collection methods as well as the method of data analysis. Lastly, the chapter presents a brief account of the procedures followed in an attempt to meet the requirements of ethical considerations.

3.1 Research Setting

As indicated in chapter 1, the assessment of learners' conceptual development is obtained in a number of ways, such as their performance in achievement tests and reponses to questionnaires and interviews. To effectively obtain valid data, learners at the senior phase i.e. grades 8 and 9 in four township high schools in the Metro Central District in the Western Cape were targeted for the study.These particular schools were selected due to the fact that they have senior phase learners in their schools that offer physical science. Secondly, they used Afrikaans, Xhosa and English for instructional purposes. Thirdly, the schools were located within the same vicinity and were within easy reach for the investigator.

For ease of reference, the schools were designated as schools A, B, C and D for the purpose of this research work. In school A, the classes ranged from Grade 8 to Grade12, and the first language of the majority of the students in this school is Xhosa.School B was largely dominated by Afrikaans-speaking students and the classes ranged from Grade 8-12. In school C and D, the classes also ranged from Grade 8- 12.These schools were also dominated by isiXhosa speaking students.In these schools,the language of learning andteaching (LOLT) are English as the first language and Afrikaans or Xhosa as a second language.The study was conducted after teaching time. I made an effort to ensure that the school timetables were not interrupted.

3.2 Sampling

Punch (2009) highlighted the two types of sampling as probability and non-probability or purposive sampling. Probability sampling is the selection of variables to represent a larger population, either by simple random sampling or stratified random sampling while Cohen, Manion, and Morrison (2011) assert that researchers often use the purposive sampling technique by selecting their samples on the basis of their judgment of the typicality and experience of the central phenomenon in their studies. Likewise, McMillan and Schumacher (2014) also agree that purposive samples are chosen because they are likely to be acquainted with the phenomena which the researcher is investigating.

However, probability sampling is commonly used in quantitative research which is relevant to this study while purposive sampling is the deliberate choice of a research population, mostly used in qualitative research, depending on the purpose and setting of the study (Punch, 2009). Both forms of sampling complement my research as a mixed methods research approachwhich focuses on an in-depth description of samples or participants.

As stated earlier, the participants in this study were comprised of two hundred and fifty senior phase learners (i.e. grades 8 & 9) in the Metro Central District in theWestern Cape.Out of the two hundred and fifty learners that participated in the tests, six learners (from the four schools) were selected for group interviews. The purposeful sample in each of the four schools was chosen to obtain additional rich information and in-depth data for the study (Geertz, 1973).The selection procedure, with the help of the teachers, took into account the gender and age of the learners. The criteria used in the selection of the purposive sample include:

- The participants must be willing to participate in the study.
- The participants must be learners at the senior phase level.
- The school must be within easy reach of the researcher.
- The participation in the study must be voluntary.
- The participants must be granted permission by their parents or guardians.

The table below shows the purposive sample for the science test and the focus group discussion.

Table 3.1 Learners' Population Sampling for School A, B, C and D.

	School A	School B	School C	School D
Number of consent forms given to the parents through the learners	50	100	60	100
Number of consent forms returned by the learners	50	80	55	90
Number of learners that took part in the test.	50	70	50	80
Number of learners that took part in the interview	1	1	2	2

As can be seen from the above table, with the assistance of the teachers, from the total number of one hundered and fifty learners in grade eight at school A, a total number of 50 learners showed their willingness to participate in the research. These learners received consent forms that needed to be approved by their parents for permission to participate in the research since they could not make the decision on their own (Silverman, 2000). All the consent forms given out to the learners, were returned. It was from this population of one hundred and fifty learners that a sample of fifty learners was carefully selected to take part in the science test. A similar procedure was followed for school B , C and D respectively.

At school B, sampling was carried out based on the total population of 100 learners in grade 8; eighty learners showed their willingness to participate in the research.They all received consent forms of which seventy were returned and they all participated in the tests.

At school C, out of the total population of one hundred and twenty learners in grade 9, sixty learners showed their willingness to participate in the research. They all received the consent forms of which fifty five were returned. Out of the fifty-five returned consent forms, fifty were chosen to complete the science test.

At school D, 100 learners in grade 9 that showed their willingness to participate in the test were given the consent form of which ninety were returned and eigthy were chosen to complete the tests. Although ten learners out of the learners that took part in the science tests in schools were expected to take part in the focus group discussions, only six learners from the the four schools actually took part in the interview. Their withdrawal did not seem strange to the researcher and they were not interrogated because of their informed right to withdraw at any phase of the research.

Considering the significant roles that educators play in learning, I thought of exploring their scientific knowledge and the classroom practices of the teachers. However, due to numerous challenges that emerged e.g.mass retrenchment among the teachers, relocation, health- and family-related issues and the fact that it was not the focus of the study, the idea was dropped. Hence, this report does not include data on classroom interactions and instruction practices of the teachers. Rather the focus of the analyses is based mainly on learners' responses to the instruments.

3.3 Research Design

According to Maxwell (2005), research design is the basis upon which all other aspects of the study depends. It is used to denote an in-depth and detailed evaluation of a subject within its context related conditions (Yin, 2014). Babbie and Mouton (2001) argue further that it is the conception, directory and the form in which a study takes place. The mechanisms of a research design include research questions, theoretical perspectives, data collection, data analysis and write-up as well as the validation processes that are adopted(Creswell, 1998).

3.4 Research Methods

As Creswell and Clark (2007) have argued, mixed methods research focuses on collecting, analysing and mixing both quantitative and qualitative data in a single study for a better understanding of the research problem. Mathipa and Mukhari (2014) have also added thatmixed methods research provides the researcher with the opportunity to seek more information. The mixed methods research design is used in this studyi.e. it combines both quantitative and qualitative methods.

The rationale for using a mixed methods approach is in line with the Vygotskian social-cultural constructivist framework underlying the study.Vygotsky stresses that the cultural environment of learners tends to give them the language with which to think, communicate and externalize their thoughts and consequently their learning. He further contends that learners do not usually come to the class with empty minds. Rather they come with ideas about various phenomena, though such ideas may be rudimentary or even faulty. Therefore teachers need to first determine the nature of learners' conceptions before introducing a new idea to them.

Mixed methods research is more flexible and enables a researcher to delve into a deeper understanding of the learners' views, beliefs, ideas, fears and thoughts about science or any subject material in question.The use of a mixed research method has given me the opportunity to collect data from different sources that would not have been the case if I had used only one method. It has also given me greater insight into the issues under investigation.

3.4.1 Quantitative research method

Balnaves and Caputi (2001) stress that quantitative research requires evidence that is observable and testable. As indicated before, this study adopted a quantitative research method for the first phase of data collection derived from the science achievement test, science vocabulary test, a context test, a picture test, and a cloze test.

The data collected were structured, described, interpreted and analyzed using both descriptive and inferential statistics to establish the learners' conceptions of magnetism, chemical change of substances and the environment.The descriptive statistics enabled me to describe the characteristics of the sample while the inferential statistics helped me to make inferences about the sample and to some extent the population from which the sample was drawn (Salkind, 2016).

3.4.2 Qualitative research method

One of the prospects of the qualitative research method is the opportunity its offer to researchers to collect data from the participants either through an interview, examination of documents, class observation and so on. Creswell and Clarke (2007) and McMillan and Schumacher (2014) opined that qualitative analysis is used for in-depth inquiry and the data consists of open-ended information that the researcher gathers.

Ogunniyi (2009) asserts that qualitative research involves the collection of experiential data or reflective data rather than data based on experimental or empirical data i.e. data with numerical values.

Denzil and Lincoln (2003) also argue eloquently that qualitative research is mainly a situated activity that locates the observer in the world. Babbie and Mouton (2001) indicated the constructive characteristics that are unique to qualitative research namely: it allows a detailed encounter with the object of study and is open to various sources of data; it is also flexible, i.e. it allows the researcher to adapt and make changes to the study where and when necessary.

Merriam (1998) asserts that activities such as interviewing, observing and analyzing are central to qualitative research and humans are well suited to be used for this task. It was in light of these, therefore, that the researcher deemed it fit to use the interview tool to further probe the learners'conceptions of magnetism, chemical change of substances and the environment. Thus, a qualitative research method was used in this study for the second phase of data collection. An interview of some selected learners was also used to collect data at this stage.

3.5 Data Collection

Data collection is the process of gathering essential information that is relevant to a particular study through different methods and sources. Data collection strategies that are consistent with mixed methods research design include document study, observations, interviews, questionnaires, and achievement tests (Henning, Van, Rensburg & Smith, 2004). The data collection tools for this research comprised the science achievement test, cloze test, science vocabulary test, picture test, context test and the interview.

My research objectives, questions, and the research context informed the design of the research instruments used. Therefore, the six data-collection tools were used to promote the credibility of the study. The selection of the method used was based not only on the research questions but also on the actual research situation and what worked most effectively in that situation to obtain the data required (Maxwell, 1996).

Moreover, the use of all these data collection instruments was to allow for triangulation. The purpose of multiple data collection strategies is to strengthen the results and to provide evidence for various aspects of the research. Data for this study were collected using a science achievement test, context text, cloze test, picture test, science vocabulary test and the interviews to explore senior phase learners' conceptions of magnetism, chemical change of substances and the environment. A focus group interview was used to gain a deeper understanding of the learners' conceptions of the concepts and their views about science. I spent two months i.e. the whole of the third term, for the collection of data at the four schools.

In other to maximize the limited time that I had for data collection and to make the data collection process much easier, a group of people consisting of two females and one male were subjected to a day of intensive training. This was to ensure that the data they collected were comparable to mine. In addition, I ensured that they were properly informed on how I wanted the data to be collected.

3.6 Reliability and Validity of the Instruments

Cozby (2001) argues that the validity of an instrument is an important issue as far as research is concerned. According to Ogunniyi (1992), a valid instrument is one that measures what it supposed to measure while reliability is the degree to which an instrument produces stable and consistent results over time. In line with Ogunniyi's (1992) recommendation, all the instruments used in the study were tested for validity and reliability to ensure that they measured what they are supposed to measure as well as to produce consistent results in two or more similar situations.

In pursuance of the purpose of the study, a number of instruments were developed to determine the learners' conceptions of the selected concepts. This entailed a rigorous step-by-step approach to ensure their validity and reliability. More specifically, copies of each instrument were given to a panel consisting of 12 seasoned science educators and experienced science teachers so as to ensure that the data collected adequately reflected the learners' conceptions of the selected concepts.

Furthermore, the instruments were given to two experts to rate each item on a scale of 1-5 (1 = poor; 2 = fair; 3 = good; 4 = very good and 5 = excellent) to obtain inter-rater validity using a modified Spearman Rank Difference formula as espoused by Ogunniyi (1992). This entailed assessing: (i) the aptness of the level of language used for the target students; (ii) the intelligibility of the questions; (iii) whether or not there were any overlapping questions and to remove them; and (iv) whether or not the content was at the level of the students.

Using the Spearman-Brown correlation reliability formula, the correlation coefficients for the six instruments stood at 0.92, 0.82, 0.88, 0.96, 0.91and 0.97 respectively, indicating a high validity and indirectly, their reliability.

3.7 Instrumentation

One of the critical aspects of curriculum implementation is assessment. Assessment instruments normally undergo a series of evaluations to ensure that they measure what they purport to measure. According to Ogunniyi (1984; 1999) An assessment instrument is said to be valid when it measures asaccurately as possible what it is designed to measure. Likewise, when an assessment instrument gives consistent results using learners from the same sample or population, it is considered to be reliable.

Another indicator of a good assessment is its technical efficiency. This relates to the approach through which the instrument has been administered in that: a) it does not favour one group over another. b) it is cost effective; c) it can be completed within a realistic time scale for a particular group of learners; d)all security matters have been properly implemented. As stated earlier, the instruments were used to elicit information regarding senior phase learners' conceptions of magnetism, chemical change of substances and the environment.

Due to the different approaches used in conducting this study, a number of instruments were used to collect the data. The instruments, adapted from Ogunniyi (1999), were modified in line with the purpose of the study. In the development of the tests, particular attention was given to ensure that the questions were unbiased, unambiguous, unloaded, relevant, succinctly conceptualized and avoided possible sources of vagueness (May, 2001).

The instruments comprised two sections namely: 1) demographic data, including the learners' gender, grade, age, career interests and first/home language; and 2) open-ended questions in which learners were asked to write answers. The six different types of instruments used are as follows:

- **Science Achievement Test**

This contains questions on selected concepts in other to establish the learners' conceptions of some scientific concepts. Questions 1-5 are on chemical changes of substances, questions 6-10 are on magnetism and questions 11 -13 are on environments. The data collected were analyzed in terms of quantitative and qualitative descriptions. Details of the findings based on the analysis of the data are presented in the next chapter.

- **Context Test**

This was used to establish the degree of conception that the learners hold in science comprehension. Science comprehension passages on magnetism, chemical change of substances and the environment were given and the learners were asked to read and rewrite the texts in their own words.

- **Cloze Test**

This was used to establish the learners' conceptions of scientific words. The learners were presented with a paragraph each on magnetism, chemical change of substances and the environment. Ten spaces were left for the students to fill in from a list of words provided for the purpose. The cloze test strategy enables students to focus on meaning and on how a text is put together.

- **Picture Test**

This was used to establish the degree of conceptions that the learners held relative to the identification of scientific diagrams orpictures. Several pictures related to selected concepts were presented and the learners were asked to write what they thought the pictures depicted.

- **Science Vocabulary Test**

This was used to establish the degree of conceptions held by the learners as evidenced in their use of appropriate scientifc vocabulary. Learners were given passages related to the selected concepts and were asked to write the words they are familiar with in the passage and then explain them in their own words.

- **Interview**

An interview is a principal tool used for data collection within the qualitative approach.Focus groups were originally called focused interviews or group in-depth interviews (Stewart &Shamdasani, 2014).

The technique was developed after World War II to evaluate the response of an audience to radio programs (Stewart & Shamdasani, 2014). Since then, social scientists and program evaluators have found afocus-group interview to be useful in understanding how or why people hold certain beliefs about a topic or program of interest (Stewart & Shamdasani, 2014).

Parker (2005) stresses that an interview creates a flexible way to collect data and can be used for all age groups, thus making the interview a very valuable part of the research design.To further probe the students' conception of magnetism, chemical change of substances and the environment, a semi-structured interview was used to elicit information from the learners in a permissive and nurturing environment that encourages different perceptions and points of view, relating to their conceptions of the selected topics mentioned above.

The interview was recorded on a digital audio device and notes were taken on important issues mentioned by the learners. The recorded interview was transcribed for qualitative analysis. Alford (1998) argues that recorded conversations are highly reliable records that can serve as evidence in academic work. They offers a researcher an opportunity to listen to what he has recorded, over and over, until he finally understands what wasrecorded.

3.8 Selection of Interviewees

The interviews were conducted to further determine the participants' conceptions of three selected concepts. Fifteen learners from grades 8-9 were purposively selected by the researcher out of two hundreds and fifty learners that wrote the test. The interviews were scheduled beforehand and forced the researcher to anticipate difficulties that might be encountered in terms of the questioning and the terminologies. In my view, the provision of open-ended, unbiased and non-judgmental predetermined questions allowed the participants to respond and express their views as freely and comfortably as possible.

Furthermore, the probing questions were asked based on the learners' beliefs, experiences and ways of thinking and reasoning about the concepts expressed during the interviews. Each interview session was planned for 30 minutes to give the interviewees sufficient time to respond to the questions. The interviewees in grade eight and nine were identified as SPL(Senior Phase Learners) SPL8(1), SPL8(2), SPL8(3), SPL9(1), SPL9(2) and SPL9 (3).The table below is the profile of the learners that participated in the interview.

Table 3.2 Profile of the Participants

Participants	Participant's Age	Participant's Gender	Participant's First Language
SPL8(1)	13years	Female	Xhosa
SPL9(1)	14 years	Male	Xhosa
SPL9(2)	16 years	Male	Afrikaans
SPL8(2)	13 years	Female	Afrikaans
SPL9(3)	14 years	Female	English
SPL8(3)	12 years	Male	English

3.8.1 Interview Setting

The interview was conducted in the classrooms where the learners wrote the tests i.e. where the noise level was low to ensure maximum participation and better recording. The relatively open nature of the interviews permitted the researcher and the interviewees to build a relationship of mutual trust. The interview was conducted in English, their language of learning and teaching (LOLT) to allow learners to express themselves fully and to be encouraged to speak freely (Ramorogo, 1998).This group of learners was interviewed twice, with the preliminary interview conducted after the learners had completed the tests.

The first interview started with becoming acquainted with the learners and establishing a good relationship and trust with them. The interviewees were asked ten questions. The same questions were asked at the second interview. This was done in order to enable the learners to ascertain their responses during the second interview. The interviews were recorded using a voice recorder and transcribed with strict preservation of the interviewees' responses.

3.8.2 Recording

Voice recorders were used to record the learners' responses during the group interview in order to enable the researcher to further investigate their conceptions as well as track their thinking relative to the three selected science concepts. The recordings created the opportunity for me to determine their understanding of magnetism, chemical change of substances and the environment.

3.9 Data Analysis

Data analysis is the breaking down of data in order to highlight useful information for suggestion and decision making. All the data were analysed in terms of statistical correlations between the measured variables such as age, gender and language. The SPSS and SAS (social sciences statistical computer software) were used to analyse and plot the data statistically. SPSS (originally, Statistical Package for the Social Sciences, later modified to Statistical Product and Service Solutions), is among the most widely used programs for statistical analysis in social science.

The SPSS statistical software program is used by market researchers, health researchers, survey companies, government, education researchers, and others, to analyse research data.

The original SPSS manual has been described by Dowling and Brown (2010) as ‘one of sociology’s most influential books’. In addition to statistical analysis, data management (case selection, file reshaping, creating derived data) and data documentation are important features of the base software.

Data collected from the various instruments were analyzed quantitatively and qualitatively. This gave the researcher a better opportunity to re-check the reliability values, the legitimacy of the data sample test as well as themethod required in answering the questions. The quantitative data was analyzed using SPSS statistics program because of its credibility in social science research. The quantitative descriptions include descriptive statistics such as the means, standard deviations, and percentages, while the inferential statistics include t-test and Analysis of Variance (ANOVA). The findings were discussed in the context of the existing literature. The conclusions reached and their implications for curriculum development, policy making, and educational practices, were highlighted.

3.10 Ethical Consideration

The ethical statement is the code of conduct that guides the relationship between researchers and participants. Swann and Pratt (2003) stress that for both moral and practical reasons,ethical considerations are considered necessary. Neuman (2003) also asserts that in a research study, the researcher needs to explain to the participants what the research entails and why the data is being collected in a particular setting. In light of this, ethical consideration was sought for throughout the study. The procedure and the process followed for this are described in detail below.

3.10.1 Letter from authorities to give consent

Ethical clearance was sought from the Education Higher Degree Committee (EDUHDC) and Senate Higher Degree Committee (SHDC) at the University of the Western Cape (UWC).After the approval from EDUHDC and SHDC at UWC, I sought permission from the Western Cape Education Department (WCED) to conduct the study in the four schools selected for the study (see Appendices A and B). The letters sent to the various stakeholders were to ensure adherence to the required guidelines that would establish an acceptable relationship between the participants and the researcher.

On my arrival at the schools selected for the study, copies of the letters were presented to the principals of the schools with a letter of permission (see appendix G)to seek their permission to conduct the study in their schools. I was warmly welcomed by the principals and the teachers in the schools. They all promised to give me their maximum support which they ultimately did. Hence, the selection of the participants that participated in the study was not as tedious as I had envisaged because of the support that I got from the Heads of Departments (HODs) and the science teachers in the schools. This positive mindset of the four principals and their teachers contributed in no small way to the ease with which the data that were collected.

3.10.2 Openness about Participation

In other to ensure that every participant had a better understanding of their roles in the research, and the value they would add both to the research and the quality of their education, I ensured that the participants were fully informed of what my research was all about, including the kind of research instruments to be used.

3.10.3 Consent Letter given to the Learners and their Parents for Participation in the Research.

Christian (2005) stresses that participants in any research need to be given the opportunity to willingly participate in research work and that their human freedom should be appreciated. In this regard, the learners were given a letter of information regarding the survey and the interview, as well as consentforms toindicate whether they would be willing to participate in the study (see Appendices H, I, L, and M).

All the participants were encouraged to participate willingly in the research and they were informed about their right to withdraw voluntarily at any time without being reprimanded. The learners were also told that all the information shared in the focus group discussion would be kept confidentialas well as their right to be recorded or not during the focus group discussion. For the same reason, the learners that did not participate in the focus group sessions were not questioned further.

Silver (2000) opined that parental consent to their children's participation in any research is very important due to the fact that children are not sufficiently competent to take decisions on their own regarding whether or notto participate in the research process.

Therefore, the parents were also given the letter of information regarding the study and consent form through the learners, which explained to them the essence of the study, the roles that their children would play and the ethical issues guiding their participation (see Appendices J and K). Learners were encouraged to bring the consent form back after a week, although some of them took longer than expected and many failed to return them. Only those children whose parents gave consent were allowed to participate in the research process. It was therefore assumed that parents who did not return the consent forms were not eager to permit their children to take part in the research.

3.10.4 Anonymity

Cohen, Manion and Morrison (2011) suggest that the participants' identities must be protected if there is the likelihood that they may unveil information that could be of personal or sensitive in nature.

Thus, all participants in the three schools were instructed right from the beginning of the study not to mention their names when writing the tests and when giving their responses during the interview.

3.10.5 **Privacy and Identity**

Christians (2005) stated that the codes of ethics shouldinform the researcher on how to protect theparticipants' identities and those of research locations. Christians (2005) also advocates that when the agreement of confidentiality is in place, data collected ought to be secured or protected and made known without revealing the identity of the participants.

Therefore, certain measures were put in place to keep the information obtained from the participants and the research locations confidential (Cohen et al., 2011).This is why the names of the participants and the schools are not mentioned in the study. For instance,the schools used in this study were designated only as schools A, B, C and D. The participants in the study were also given pseudonyms to protect their identities.

3.11 Coding

For easy identification of the instruments used in this study, codes were given to the instruments. SAT stands for the Science Achievement Test, SVT indicates the Science Vocabulary Test, COT indicates A Context Test, PIT indicates the Picture Test, CLT indicates the Cloze Test and SPL stands for Senior Phase Learner.

3.12 Summary

This chapter describes theresearch design and the methodology used in carrying out the study. In the study, the researcher utilized both quantitative and qualitative research methods for the collection and analysis of data. As stated earlier, the Science Achievement Test, Science Vocabulary Test, Context Test, Picture Test and the Cloze Test provided data for the quantitative aspect of the study while the interview provided data for the qualitative aspect of the study. In the first phase, 250 learners wrote the tests. Their performance was analyzed quantitatively in response to the questions on their conceptions of magnetism, chemical change of substances and the environment.

A qualitative research methodology was utilized to collect and analyze data during the second phase of the study. Pre-interviews were conducted to gather data for this phase of the study. The interview was audio-taped and then transcribed and analyzed. The questions for the interviews were drawn to cover all the aspects associated with the study in order to obtain valid and reliable datafrom the participants. The next chapter provides a detailed account of the analyses of the findings.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Introduction

This chapter presents and discusses the results of the data collected from the study. The study wasconducted to ascertain the conceptions of grade eight and nine learners of magnetism, chemical change of substances and the environment.The study was specifically designed to collect a robust data-set using different assessment instruments in order to provide answer**s** to the following questions:

1. What conceptions of magnetism, chemical change of substances and the environment do grades 8 and 9 learners hold?
2. Is there any relationship between the learners' age, gender, language and their conceptions of magnetism, chemical change of substances and the environment?

The study drew inspiration largely from socio-cultural constructivism as espoused by Vygotsky (1978). Socio-cultural constructivism construes learning as a social activity which involves the learner and a knowledgeable person e.g. an educator. It also asserts that social interaction is an essential component of cognitive development in learning.

Forease of reference, the data were analyzed in terms of the questions posited for soluton. This entails by presenting first the Quantitative analysis in form of Tables followed by excerpts derived from the comments , explanations and views expressed by the subjets.

4.1 First Research Question

FIRST QUESTION: What conceptions of magnetism, chemical change and the environment do grade eight and nine learners in selected schools in Cape Town hold of magnetism, chemical change of substances and the environment?

In this study, the learners' conceptions of magnetism, chemical change of substances and the environment, were obtained from the five tests they wrote namely: Science Achievement Test(SAT), ContextTest(COT), ClozeTest(CLT), PictureTest(PIT), ScienceVocabulary Test(STV) and the Interviews.

4.1.1 Grade 8 and 9 learners' conceptions of magnetism, chemical change and the environment in the Science Achievement Test (SAT)

Table 4.1. The conceptions that grade 8 and 9 learners hold of magnetism, chemical change and the environment in Science Achievement Test (SAT).

Variable	**N**		**Magnetism**				**Chemical change**				**Environment**			
	G8	G9	G8		G9		G8		G9		G8		G9	
	N	*N*	Mean	STD	Mean	STD	Mean	STD	Mean	STD	Mean	STD	Mean	STD
Boys	45	61	6.49	1.82	5.90	3.48	4.89	2.75	5.74	3.52	3.64	3.65	5.00	3.54
Girls	55	89	5.82	2.86	5.39	3.79	5.56	2.69	5.39	3.79	4.04	3.74	5.34	3.60
English	13	11	8.00	2.31	6.36	3.23	7.85	0.99	8.64	3.23	8.62	1.26	5.91	3.75
Afrikaans	18	16	5.22	3.00	5.94	3.28	5.00	2.68	5.94	3.75	2.22	2.65	5.31	3.40
IsiXhosa	69	123	6.00	2.17	5.49	3.76	4.84	2.71	5.20	3.59	3.39	3.54	5.12	3.59
12 years	5	-	8.00	1.41	-	-	8.40	1.67	-	-	7.20	1.79	-	-
13 years	39	8	6.36	2.19	3.75	4.43	5.23	2.54	5.00	2.67	3.54	3.32	5.00	2.67
14 years	49	104	6.04	2.47	5.52	3.78	3.80	3.98	5.57	3.86	3.80	3.98	5.33	3.60
Above 14	7	37	4.00	3.27	6.25	3.02	3.71	3.90	5.56	3.33	3.71	3.90	4.86	3.68

The data-set displayed in Table 4.1 above is derived from the Science Achievement Test (SAT). For magnetism, the table indicates that grade eight boys with the mean value (M = 6.49, SD = 1.82) outperformed their female counterparts (M = 5.82, SD = 2.86). Similarly, grade nine boys (M = 5.90, SD = 3.79) also outperformed the girls (M = 5.39. SD = 3.48). In the case of gender variation, within each group, their performance appears to be homogenous. Among the four age groups in grade eight, the 12 year olds had the highest mean score followed by the 13 year olds then the 14year olds and lastly the above 14year olds, whereas in grade nine, the above 14 year olds had the highest mean score followed by the 14year olds and lastly the 13 year olds. However, in grade nine, only seven learners are in the above 14year olds groups that performed, hence their number may be an advantage to them because the smaller the number, the larger the overall mean. Moreover, the 13 year olds group in grade nine appears to be heterogeneous. With regard to language in grade eight, the English speaking group performed better than the Xhosa speaking group and the latter performed slightly better than the Afrikaans speaking group. In grade nine, the English speaking group performed better that the Afrikaans speaking group and the latter performed better than the Xhosa speaking group. Similarly, the variation within each group appears homogenous.

On the topic of chemical change, the table indicates that in grade eight, girls with the mean value (M = 5.56, SD = 2.69) performed better than grade eight boys (M = 4.89, SD = 2.75). In grade nine, the boys with the mean value (M = 5.74, SD = 3.52) performed better than the girls (M = 5.39, SD=3.79). However, the variation within each group appears homogenous. In addition, among the four age groups in grade eight, the 12year olds had the highest mean score followed by the 13year olds then the 14year olds and lastly the above 14 year olds while in grade nine, 14 year olds had the highest mean score followed closely by the above 14year olds and lastly the 13year old group. With regard to language in both grades eight and nine, the English speaking group performed better than the Afrikaans speaking group and the latter performed slightly better than the Xhosa group. The variation within each group appears homogenous.

As far as performance in environment is concerned, in terms of gender in both grades eight and nine, girls with the mean value (M = 4.04, SD = 3.74) and (M = 5.34, SD = 3.60) respectively, performed better than the boys. Moreover, among the four age groups in grade eight, the 12 year olds had the highest mean score followed by the 14 year old group, then the above 14 year olds and lastly the 13 year olds. In grade nine, the 14 year old group had the highest mean score followed by the 13 year old group and lastly the above 14 year olds. With regard to language in grade eight, the English speaking group performed much better than the Xhosa speaking group and the latter performed better than the Afrikaans speaking group. In grade nine, the English speaking group performed better than the Afrikaans group and the latter performed better than the Xhosa speaking group. Again the low standard variations within each group showed a high level of homogeneity.

Table 4.2 An overall summary of grades 8 and 9 learners' conceptions of magnetism, chemical change and the environment in the Science Achievement Test (SAT)

Variable	**Grade 8**			**Grade 9**		
	Gender t-ratio	Age F-ratio	Language F- ratio	Gender t-ratio	Age F-ratio	Language F-ratio
Magnetism	1.36	3.02	5.55	-4.38	0.78	18.00
Chem. Change	-1.24	2.51	7.69	-2.18	0.05	16.01
Environment	-0.53	1.50	17.53	-2.47	1.53	19.66

Alpha=0.05, t critical =1.98; F critical=2.60(Age) F critical =3.00(Language)

The data-set displayed in Table 4 above is derived from the Science Achievement Test (SAT) to provide the inferential summary of the conceptions of grade eight and nine in the three concepts in science achievement test.

Conceptions of magnetism in the Science Achievement Test (SAT)

In terms of gender in grade eight, the difference between their mean scores is not statistically significant (t-crit. = 1.98 at p = 0.05) while in grade nine, the difference between their mean scores (t-ratio = -4.38) is statistically significant (Crit.-t = 1.98 at p = 0.05). The overall difference in grade eight performance in term of age is statistically significant at t = 2.60 p = 0.05 while in grade nine the overall difference in their performance is not statistically significant at t = 2.60 at p = 0.05. In terms of language, the difference between the mean scores is statistically significant at t = 3.00 at p = 0.05 in both grade eight and nine.

Conceptions of chemical change in the Science Achievement Test (SAT)

In terms of gender, the difference between the mean scores is not statistically significant at t =1.98 at P = 0.05 in both grades eight and nine. Similarly, in respect to age, the overall difference in grade eight and nine performance is not statistically significant at F = 2.60 at p = 0.05. With regards to language, according to the F value 3.00 at p = 0.05) in both grades eight and nine, the differences among the mean scores are statistically significant.

Conceptions of environment the in Science Achievement Test (SAT)

In terms of gender, the difference between the mean scores in grade eight is not statistically significant at t = 1.98 p = 0.05 while it is statistically significant in grade nine. In term of age, the overall difference in both grade eight and nine performance is not statistically significant at t = 2.60 at p = 0.05 but with respect to language according to the F-value = 3:00 at p = 0.05), the difference among the mean scores in both grade eight and nine is statistically significant.

4.1.2 Grades 8 and 9 learners' conceptions of magnetism, chemical change and the environment in the Context Test (COT)

Table 4.3 The conceptions that grade 8 and 9 learners hold of magnetism, chemical change of substances and the environment in Context Test (COT).

Variable	N		Magnetism				Chemical change				Environment			
	G8	G9	G8		G9		G8		G9		G8		G9	
	N	N	Mean	STD	Mean	STD	Mean	STD	Mean	STD	Mean	STD	Mean	STD
Boys	45	61	4.44	2.86	3.93	2.87	4.44	2.25	4.62	2.49	5.24	3.34	4.69	2.47
Girls	55	89	5.60	3.52	4.83	2.21	6.04	3.12	4.83	2.47	6.22	3.21	3.92	2.65
English	13	11	9.08	2.53	4.91	2.43	7.38	2.63	4.00	2.19	8.46	1.66	5.89	2.91
Afrikaans	18	16	5.11	3.09	5.38	2.50	5.67	3.01	5.13	2.45	6.11	3.18	4.38	2.85
IsiXhosa	69	123	4.32	2.94	4.31	5.54	4.84	2.7	4.98	2.51	5.19	3.31	4.33	2.55
12 years	5	-	6.00	3.46	-	-	7.20	2.68	-	-	8.80	3.03	-	-
13 years	39	8	4.77	3.07	4.25	2.25	5.18	2.93	4.25	1.28	4.87	3.30	5.00	2.39
14 years	49	104	5.35	3.50	4.51	2.45	5.06	2.92	5.04	2.49	6.29	3.12	4.20	2.70
Above 14	7	37	4.29	2.93	4.39	2.86	6.57	1.51	4.72	2.67	5.14	3.24	4.17	2.36

Alpha=0.05, t critical =1.98; F critical=2.60(Age) F critical =3.00(Language)

As can be seen from table above for magnetism in term of gender both in grades eight and nine, the girls had a mean score of (M = 5.60, SD = 3.52) and (M = 4.83, SD = 2.21) respectively and performed better than the boys. Also, the variation within the group appears homogenous.

With regard to the age group in grade eight, the 12 year old group performed the best followed by the 14 year old group then the 13 year old group and then lastly the above 14 year old group. In grade nine, the 14 year old group performed the best, followed by the above 14year olds and lastly the 13 year olds. Again, as in the case of age, variation within each group appears homogenous. In term of language in grade eight, the English speaking group performed much better than the Afrikaans speaking group and the latter performed better than the Xhosa speaking group. In grade nine, the Afrikaans speaking group performed better than the English speaking group and the latter performed better than the Xhosa speaking group. Moreover, the Afrikaans speaking group in grade nine appears to be heterogeneous.

Furthermore, for chemical change in both grades eight and nine, the girls with the mean score (M = 6.04, SD = 3.12) and (M = 4.83, SD = 2.47) respectively performed better than the boys. The variation within the group appears homogenous. In respect to age in grade eight, the 12 year olds had the highest mean score followed by the 14 year old group then the 13 year old group and then lastly the above 14 year old group. In grade nine, the 14 year old group performed better followed by the above 14 years old and lastly the 13 year olds. Again, the variation within the group is homogenous. With regard to language in grade eight, the English speaking group performed better than the Afrikaans speaking group and the latter performed better than the Xhosa speaking group. In grade nine, the Afrikaans speaking groups performed better than the Xhosa groups and the latter performed better than the English speaking groups. As in the case of language, the variation within the group also appears homogenous.

For environment, according to performance by gender, in grade eight the girls performed better than the boys with the mean score (M = 6.22, SD = 3.21) while grade nine boys with the mean score (M = 6.49, SD = 2.47) performed better than the girls. Furthermore, among the four age groups, in grade eight the 12 year olds had the highest mean score followed by the 14 year old group then the above 14 year old group and then lastly the 13 year olds. In grade nine, the 13 year old group performed better followed by the 14year olds and lastly the above 14 year olds. With regard to language, in both grades eight and nine the English speaking group performed much better than the Afrikaans speaking group and the latter performed better than the Xhosa speaking group. The English speaking group in grade nine appears to be heterogeneous.

Table 4.4. The overall summary of grades 8 and 9 learners' conceptions of magnetism, chemical change and the environment in the Context Test.

Variable	Grade 8			Grade 9		
	Gender t-ratio	Age F-ratio	Language F-ratio	Gender t-ratio	Age F-ratio	Language F-ratio
Magnetism	-1.556	1.500	5.617	-2.733	0.319	6.917
Chem. Change	-1.266	0.332	4.362	-2.354	0.972	8.180
Environment	-1.256	0.240	6.70	-2.385	0.390	1.591

Alpha=0.05, t critical = 1.98; F critical = 2.60(Age); F critical = 3.00 (Language)

The data-set displayed in Table 4.4 above is derived from the Context Test (COT) to give the inferential summary of the conceptions of grades eight and nine of the three concepts in the context test.

Conceptions of magnetism in the Context Test (COT).

With regard to gender, the difference between the means in grade eight is not statistically significant with scores at t =1.98 at p = 0.05 while it is statistically significant in grade nine. In term of age, according to the F value 2:60 at p = 0.05), the difference among the mean scores in both grades is not statistically significant. In respect to language, according to the F value 3:00 at p = 0.05. The difference among the mean scores is statistically significant in both grade eight and nine.

Conceptions of chemical change in the Context Test (COT)

Based on the performance according to gender, the differences among the mean scores in grade eight is not statistically significant at t =1.98 at p =0.05 but statistically significant in grade eight at t =1.98 at p = 0.05. In terms of performance according to age, the difference among the mean scores in both grade eight and nine is not statistically significant at F value 2.60 at p = 0.05. The difference among the mean scores according to performance in terms of language is statistically significant at F = 3.0 at p = 0.05 in both grades.

Conceptions of environment in the Context Test (COT)

With regards to gender, the difference between the mean score in grade eight is not statistically significant at t =1.98 at p = 0.05 while the difference between the mean score is statistically significant at t =1.98 at p = 0.05. Also, variation within each group appears homogenous. In respect to gender, the difference between the mean scores in their performance according to the F- value 2.60 at p = 0.05) is not statistically significant in the two grades. In terms of language, the difference between the mean scores in grade eight is statistically significant while it is not statistically difference in grade nine at F = 3.0 at p = 0.05.

4.1.3 Grade 8 and 9 learners' conceptions of magnetism, chemical change and the environment in the Cloze Test (CLT)

Table 4.5. The conceptions that grade 8 and 9 learners hold of magnetism, chemical change and the environment in the Cloze Test (CLT).

Variable	N		Magnetism				Chemical change				Environment			
	G8	G9	G8 Mean	STD	G9 Mean	STD	G8 Mean	STD	G9 Mean	STD	G8 Mean	STD	G9 Mean	STD
Boys	45	61	5.64	1.87	4.92	3.00	5.51	2.05	4.46	2.72	5.29	2.42	4.59	2.74
Girls	55	89	6.33	2.56	5.16	2.92	6.29	2.02	4.70	2.63	6.33	2.33	4.96	2.72
English	13	11	8.00	1.83	4.73	2.53	6.92	1.94	5.45	2.84	7.23	2.09	3.45	3.11
Afrikaans	18	16	6.00	2.06	5.63	3.74	7.00	1.57	4.25	3.26	6.11	2.32	3.75	2.91
IsiXhosa	69	123	5.65	2.22	5.02	2.88	5.48	2.05	4.57	2.57	5.54	2.43	5.07	2.62
12 years	5	-	6.80	2.68	-	-	6.80	2.28	-	-	6.00	1.41	-	-
13 years	39	8	6.15	1.97	3.00	3.21	5.69	2.13	5.00	3.38	5.79	2.51	4.25	1.67
14 years	49	104	5.88	2.40	5.07	2.82	6.04	2.02	4.66	2.62	6.00	2.45	4.93	2.74
Above 14	7	37	5.71	2.91	5.50	3.15	6.00	2.00	4.33	2.68	5.14	2.55	4.56	2.89

The data-set displayed in Table 4.5 above is derived from the Cloze Test (CLT). For magnetism the table indicates thatin terms of performance according to gender, in both grade eight and nine the girls perform better than the boys. (M = 6.33, SD = 2.56) and (M = 5.16, SD = 2.92) respectively. Also, the variation within each group appears homogenous. Of the four age groups in grade eight, the 12 year olds had the highest mean score in grade eight followed by the 13 year old group then the 14 year old group and then lastly the above 14 year olds. In grade nine, the above 14 year old group performed the best followed by the 14 year olds and lastly the 13 year olds.

With regard to language in grade eight, the English speaking group performed better than the Afrikaans speaking group and the latter performed better than the Xhoza speaking group. In grade nine, the Afrikaans group performed better than the Xhosa speaking group and the latter performed better than the English group. The variation within each group appears homogenous.

On the topic of chemical change,in terms of performance according to gender, in both grade eight and nine the girls performed better than the boys with the mean scores (M = 6.29, SD = 2.02) and (M = 4.70, SD = 2.63) respectively . Furthermore, the variation within the group appears homogenous. Furthermore, in grade eight, the 12 year old group performed the best, followed by the 14 year old group, then the above 14 year old group and then lastly the 13 year old group. In grade nine, the 13 year old group performed the best, followed by the 14year olds and lastly the above 14 year olds. Again, the variation within the group appears homogenous. With regard to language in grade eight, the Afrikaans speaking group performed slightly better than the English speaking group and the latter performed better than the Xhoza speaking group. In grade nine, the English speaking group performed better than the Xhosa speaking group and the latter performed better than the Afrikaans speaking group.

As far as performance in environment is concerned, in both grade eight and nine the girls with the mean score (M = 6.33, SD = 2.33) and (M = 4.96, SD = 2.72) respectively, performed better than the boys. The variation within each group appears homogenous. Additionally, in grade eight, the 12 and 13-year-old groups performed better than the 13 year olds and the latter performed better than the above 14 year olds while in grade nine the 14 year old group performed the best followed by the above 14year olds and lastly the 13 year olds. Also, in terms of language in grade eight, the English speaking group performed better the Afrikaans speaking group and the latter performed better than the Xhosa speaking group while in grade nine the Xhoza speaking group performed better than the Afrikaans speaking group and the latter performed better than the English speaking group. Again, the variation within the group appears homogenous.

Table 4.6 An overall summary of grades 8 and 9 learners' conceptions of magnetism, chemical change and the environment in the Cloze Test (CLT)

Variable	**Grade 8**			**Grade 9**		
	Gender t-ratio	Age F-ratio	Language F-ratio	Gender t-ratio	Age F-ratio	Language F- ratio
Magnetism	-2.128	0.316	17.753	-1.498	2.610	9.210
Chem. Change	-2.729	2.047	15.994	-1.227	0.662	9.385
Environment	-2.737	0.331	9.059	-1.999	0.938	8.427

Alpha=0.05, t critical =1.98; F critical=2.60(Age) F critical =3.00(Language)

The data-set displayed in Table 4.6 above is derived from the Cloze Test (CLT) to provide an inferential summary of the conceptions of grade eight and nine of the three concepts in the Cloze Test.

Conceptions of magnetism in the Cloze Test(CLT)

With respect to gender, the difference between the two groups in grade eight is statistically significant while it is not statistically significant in grade nine at t = 1.98 at p = 0.05. In both grade eight and nine, in terms of gender, the difference among the mean score is not statistically significant according to the F- value 2.60 at p = 0.05. With regard to language, the difference between the mean scores in grade eight is highly and statistically significant at F= 3.0 at p = 0.05 and is also statistically significant at F = 3.0 at p = 0.05 in grade nine.

Conceptions of Chemical change in the Cloze Test(CLT)

In terms of gender, the difference between the mean scores in grade eight is statistically significant while in gradenine it is not statistically significant at t =1.98 at p = 0.05.According to their performance based on their age group, the difference between the mean scores in both grades eight and nine is not statistically significant at F- value 2.60 at p = 0.05). In respect to language in grade eight the difference between the mean scores is highly and statistically significantat F = 3.0 at p = 0.05. Also, in grade nine, the difference between the mean score is also statistically significant but not as high as it is in grade eight.

Conceptions of environment in the Cloze Test (CLT)

With regards to gender, the difference between the mean scores are statistically significant at t =1.98 at p = 0.05 in both grades. In respect to age, the difference between the mean scores is not statistically significant at F = 2.60 at p = 0.05. According to the F- value 2.60 at p = 0.05), the difference between the mean scores is not statistically significant. In terms of language,the difference between the mean scores in both grades eight and nine, isstatistically significant at F= 3.00 at p = 0.05.

4.1.4 Grade 8 and 9 learners' conceptions of magnetism, chemical change and the environment in the Picture Test (PIT).

Table 4.7 The conceptions that grade 8 and 9 learners hold of magnetism, chemical change of substances and the environment in the Picture Test (PIT).

Variable	**N**		**Magnetism**				**Chemical change**				**Environment**			
	G8	G9	G8		G9		G8		G9		G8		G9	
	N	N	Mean	STD	Mean	STD	Mean	STD	Mean	STD	Mean	STD	Mean	STD
Boys	45	61	5.62	3.59	5.90	3.48	6.22	3.56	5.74	3.52	5.67	3.78	5.00	3.54
Girls	55	89	6.11	3.14	5.62	3.83	6.18	3.47	5.51	3.77	5.91	3.61	5.45	3.67
English	13	11	6.54	3.76	8.18	2.52	6.54	3.75	9.55	1.51	6.15	3.63	6.82	4.05
Afrikaans	18	16	6.39	3.35	5.94	3.28	6.39	3.35	5.94	3.75	6.39	3.35	5.31	3.40
IsiXhosa	69	123	5.64	3.28	5.49	3.76	5.64	3.28	5.20	3.56	6.16	3.55	5.12	3.59
12 years	5	-	5.00	3.54	-	-	6.00	4.18	-	-	5.00	5.00	-	-
13 years	39	8	6.18	3.33	3.75	4.43	6.28	3.88	5.00	2.67	6.15	3.35	5.00	2.67
14 years	49	104	5.57	3.29	5.71	3.85	6.12	3.57	5.66	3.85	5.71	3.95	5.42	3.66
Above 14	7	37	7.14	3.94	6.25	3.02	6.43	3.78	5.56	3.33	5.00	2.89	4.86	3.68

An examination of the above table shows that, on the topic of magnetism in grade eight, girls with the mean score (M = 6.11, SD = 3.14) performed better than the boys while in grade nine, boys with the mean score(M = 5.90, SD = 3.48) performed better than the girls. Also, in terms of age, in grade eight the above 14 year old groups performed the best followed by the 13 year olds then the 14 year olds and lastly the 12 year olds while in grade nine the 14 year old group performed better followed by the above 14 year olds and lastly the 13 year olds. Also, the 13 year old group in grade nine appears to be heterogeneous. Furthermore, with regards to language, in both grades eight and nine, the English speaking group performed better than the Afrikaans speaking group and the latter performed better than the Xhosa group.

On the topic of chemical change, in grade eight the girls with the mean score (M = 6.18, SD =3.47) performed better than the boys but in grade nine, the boys with the mean score (M = 5.74, SD = 3.52) performed better than the girls. Also, in grade eight, the above 14 years old groups performed the best followed by the 13 year olds then the 14 year olds and lastly the 12 year olds. In grade nine, the 14 year old group performed the best followed by the above 14 year olds and lastly the 13 year olds. In terms of language, in grade eight and nine the English speaking group performed better than the Afrikaans speaking group and the latter performed better than the Xhosa speaking group.

On the topic of environment, in both grades eight and nine the girls with the mean scores (M = 5.91, SD = 3.61) and (M = 5.45, SD = 3.67) performed better than the boys.Also in grade eight, the 13 year olds performed the best followed by the 14 year olds, then the 12 year olds and lastly the above 14 year olds while in grade nine the 14 year old group performed the best followed by the 13 year olds and lastly the above 14 year olds. Furthermore, in terms of language in grade eight the English speaking group performed better in magnetism and chemical change while the Afrikaans speaking group performed better in the environment. Also, in grade nine the English speaking group performed better in all the three concepts. Moreover, as in the case of language, the English speaking group appears heterogeneous.

Table 4.8 An overall summary of grades 8 and 9 learners' conceptions of magnetism, chemical change and the environment in the Picture Test (PIT)

Variable	Grade 8			Grade 9		
	Gender t-ratio	Age F-ratio	Language F-ratio	Gender t-ratio	Age F-ratio	Language F-ratio
Magnetism	-1.56	1.50	5.62	0.46	1.53	2.80
Chem. Change	-1.13	0.33	4.36	0.38	0.12	7.84
Environment	-0.57	0.24	6.70	-0.75	0.35	0.25

Alpha = 0.05, t critical = 1.98; F critical = 2.60(Age) F critical =3.0 (Language).

The data-set displayed in Table 4.8 above is derived from the Picture Test (PIT) and provides the inferential summary of the conceptions of grades eight and nine of the three concepts in the picture test.

Conceptions of magnetism in the Picture Test (PIT).

In respect to gender,the difference between their performance in both grade eight and nine is not statistically significant at t = 1.98 at p = 0.05. In terms of age, the difference between the mean scores in both grades is not statistically significant at F = 2.60 at p = 0.05. Also, according to their performance based on language, the difference in the mean scores in both grades is statistically significant at F = 3.00 at p = 0.05.

Conceptions of chemical change in the Picture Test (PIT).

On the topic of chemical change,according to gender, the difference between their performance in both grades is notstatistically significantat t =1.98 at p = 0.05. Likewise, in terms of age, the difference between the mean scores in both grade eight and nine is not statistically significant at F = 2.60 at P = 0.05. Also in respect to language, the difference among the mean scores in both grades is statistically significant at F = 3.0 at p = 0.05.

Conceptions of environment in the Picture Test (PIT).

In terms of gender, the differences between the mean scores in both grades are not statistically significant at t =1.98 at p = 0.05. In regard to age, the difference between the mean scores in both grades is not statistically significant at F = 2.60 at P = 0.05. In respect to language, the difference between the mean scores is statistically significant at F =3.0 at P = 0.05 in grade eight while the difference among the mean scores is not statistically significant at F = 3.0 at P = 0.05 in grade nine.

4.1.5 The conceptions that grade 8 and 9 learners hold of magnetism, chemical change of substances and the environment in the Science Vocabulary (SVT).

Table 4.9 The conceptions that grade 8 and 9 learners hold of magnetism, chemical change of substances and the environment in the Science Vocabulary Test (SVT).

Variable	N		Magnetism				Chemical change				Environment			
	G8 N	G9 N	G8 Mean	STD	G9 Mean	STD	G8 Mean	STD	G9 Mean	STD	G8 Mean	STD	G9 Mean	STD
Boys	45	61	5.67	3.18	5.97	3.36	6.36	2.90	5.75	3.49	5.42	3.61	5.36	3.43
Girls	55	89	6.93	2.38	5.97	3.17	7.00	2.65	6.00	2.10	6.36	3.04	5.85	2.99
English	13	11	8.31	2.25	8.55	1.51	7.69	1.84	9.36	1.12	8.92	1.89	8.75	1.27
Afrikaans	18	16	6.78	2.94	5.88	3.14	6.22	3.21	6.00	3.74	5.56	2.96	5.25	3.26
IsiXhosa	69	123	5.88	2.75	5.75	3.28	6.65	2.79	5.58	3.08	5.48	3.19	5.43	3.15
12 years	5	-	5.80	2.38	-	-	6.00	4.18	-	-	6.00	4.18	-	-
13 years	39	8	6.13	3.07	5.62	3.25	6.59	2.83	5.00	2.67	6.05	3.01	5.75	1.75
14 years	49	104	6.39	2.68	5.87	3.41	6.98	2.52	6.01	3.29	5.88	3.43	5.75	3.27
Above 14	7	37	7.36	2.73	6.33	2.71	6.00	3.46	5.78	3.07	5.71	2.56	5.36	3.16

Table 4.9 above shows grades 8 and 9 learners' performance on the science vocabulary test (STV) relative to the three concepts. With respect to magnetism, grade eight girls achieving a mean score (M = 6.93, SD = 2.38) performed better than the boys while in grade nine both the boys and the girls appeared homogenous in that they had the same mean score (M = 5.97) but slightly different STD(SD = 3.36; SD = 3.17) respectively. Also in terms of age, grade eight learners the above 14 years of age performed the best followed by the 14 year olds then the 13 year olds and lastly the 12 year olds. Also, in grade nine, the

above 14 year old group performed the best followed by the 14 year olds and lastly the 13 year olds. Besides, in grade eight, the 13 year old group appears to be homogeneous while the 14year old group in grade nine appears to be heterogeneous. Furthermore, with regards to language in both grades eight and nine, the English speaking group performed better than the Afrikaans speaking group and the latter performed better than the Xhosa group.

On the topic of chemical change, in both grade eight and nine the girls with the mean scores (M = 7.0, SD = 2.65), (M = 6.0, SD = 2.10) performed better than the boys. Also, in grade eight, the above 14 year olds performed the best followed by the 13 year olds while the 12 year olds and the above 14 year olds had the same mean score (M = 6.0) but different (SD = 4.18; SD = 3.46) respectively. However, the 12 year old group appears to be heterogeneous. In grade nine, the 14 year old group performed the best followed by the above 14 year olds and lastly the 13 year olds. In term of language, in grade eight the English speaking group performed better than the Afrikaans speaking group and the latter performed better than the Xhosa speaking group. Similarly, in grade nine the English speaking group performed better than the Xhosa speaking group and the latter performed better than the Afrikaans speaking group.

On the topic of environment,in both grades eight and nine the girls with the mean scores (M = 6.36, SD =3.04) and (M = 5.85, SD = 2.99) performed better than the boys. However, the boys in both grade nine and eight grade nine appears to be homogeneous.Also in grade eight, the 13 year olds performed the best, followed by the 12 year olds then the 13 year olds and lastly the above 14 year olds while in grade nine the 13year and 14 year old groups with the same mean score (M = 5.75) but a different STD (SD = 1.75; SD = 3.27) respectively performed the best followed by the above 14 year olds. Furthermore, in terms of language in grade eight the English speaking group performed better than the Afrikaans and the latter performed better than the Xhosa speaking group while in grade nine the English speaking group performed better than the Xhosa speaking group and the latter performed better than the Afrikaans speaking groups. Moreover, as in the case of language, the English speaking groups appear to be heterogeneous in both grades

Table 4.10 An overall summary of grades 8 and 9 learners' conceptions of magnetism, chemical change and the environment in the Science Vocabulary Test (SVT)

Variable	**Grade 8**			**Grade 9**		
	Gender t-ratio	Age F-ratio	Language F-ratio	Gender t-ratio	Age F-ratio	Language F-ratio
Magnetism	-2.26	0.80	4.57	0.02	0.32	3.93
Chem. Change	-1.16	0.43	1.11	-0.46	0.40	7.74
Environment	-1.47	0.33	7.30	-0.94	0.20	5.97

Alpha = 0.05, t critical =1.98; F critical = 2.60(Age); F critical =3.0 (Language).

The data-set displayed in Table 4.10 above is derived from the Science Vocabulary Test (SVT) and provides an inferential summary of the conceptions of grades eight and nine of the three concepts in Science Vocabulary Test. The data-set displayed in Alpha=0.05, t critical =1.98; F critical = 2.60(Age); F critical = 3.0(Language).

Conceptions of magnetism in the Science Vocabulary Test(SVT).

In respect to gender,the difference between their performance is only noticeable in grade eight where the mean is statistically significant at t =1.98 at p = 0.05. In terms of age, the difference between the mean scores in both grades is not statistically significant at F = 2.60 at p = 0.05. Also, according to their performance based on language, the difference in the mean scores in both grades is statistically significant at F = 3.0 at p = 0.05.

Conceptions of chemical change in the Science Vocabulary Test(SVT).

On the topic of chemical change according to gender, the difference between their performance in both grades is not statistically significant at t =1.98 at p=0.05. Likewise, in terms of age, the difference between the mean scores in both grades eight and nine is not statistically significant at F = 2.60 at P = 0.05. Also, in respect to language, the difference among the mean scores in grade 9 is statistically significant at F = 3.0 at p = 0.05.

Conceptions of environment in the Science Vocabulary Test(SVT).

In terms of gender, the differences among the mean scores in both grades are not statistically significant at t =1.98 at p = 0.05. In regard to age, the difference between the mean scores in both grades is not statistically significant at F = 2.60 at P = 0.05. In respect to language, the difference among the mean scores is statistically significant at F = 3.0 at P = 0.05 in both grade eight and nine.

4.1.6 Comparison of the conceptions of all grade eight and nine learners of magnetism, chemical change and the environment across all the tests

Table 4.11 A comparison of the conceptions held by grade eight and nine learners on magnetism, chemical change and the environment in the Science Achievement Test

Variable	Grade 8			Grade 9			F-ratio
	N	Mean	STD	N	Mean	STD	
Magnetism	100	6.12	2.53	150	3.91	3.31	16.51
Chemical Change	100	5.26	2.78	150	4.67	2.86	1.36
Environment	100	3.86	3.69	100	3.32	3.32	0.72

(F=3.0 at p = 0.05).

From the above table, in magnetism, the grade eight learners had mean scores of (M = 6.12, SD = 2.52), (M = 5.26, SD = 2.78) and (M = 3.86, SD = 3.32) in the three concepts and respectively performed better than grade nine learners in the three concepts. The difference between their mean scores in magnetism is highly statistically significant while it is not significant in chemical change and environment. However, the variation within each group is heterogeneous.

Table 4.12 A comparison of the conceptions held by grade eight and nine learners on magnetism, chemical change and the environment in the Context Test (COT)

Variable	Grade 8			Grade 9			F-ratio
	f	Mean	STD	f	Mean	STD	
Magnetism	100	5.14	3.31	150	4.63	2.62	4.40
Chemical Change	100	5.52	3.00	150	5.23	2.67	1.23
Environment	100	5.78	3.29	150	4.45	2.69	7.58

(F=3.00 at p=0.05)

Table 4.12 above shows that grade eight performed better in the three concepts than grade nine with the mean scores (M = 5.14, SD = 3.31), (M = 5.52, SD = 3.0) and (M = 5.78, SD = 3.29) respectively. The difference between their mean scores is statistically significant except in chemical change which is statistically significant. Moreover, the variation within each group is heterogeneous.

Table 4.13 A comparison of the conceptions held by grade eight and nine learners on magnetism, chemical change and the environment in the Cloze Test (CLT)

Variable	Grade 8			Grade 9			F-ratio
	N	Mean	STD	N	Mean	STD	
Magnetism	100	6.02	2.33	150	5.06	2.95	7.62
Chemical Change	100	5.94	2.06	150	4.60	2.65	18.13
Environment	100	5.86	2.42	150	4.80	2.71	9.80

(F=3.00 at p=0.05)

From Table 4.13 we can observe that grade eight learners performed better than grade nine learners in the three concepts with the mean scores (M = 6.02, SD = 2.33), (M = 5.94, SD = 2.06) and (M = 5.86, SD = 2.42) respectively. The difference between their mean scores is statistically significant.

Table 4.14 A comparison of the conceptions held by grade eight and nine learners on magnetism, chemical change and the environment in the Picture Test (PIT)

Variable	Grade 8			Grade 9			F-ratio
	N	Mean	STD	N	Mean	STD	
Magnetism	100	6.19	3.32	150	5.73	3.68	0.10
Chemical Change	100	6.70	3.42	150	5.60	3.66	5.70
Environment	100	5.90	3.72	150	5.33	3.60	1.45

(F = 3.0 at p=0.05)

From the above table, grade eight performed better than grade nine in the three concepts with the mean scores (M = 6.19, SD =3.32), (M = 6.70, SD = 3.42) and (M = 5.90, SD = 3.72), respectively. The difference between their mean scores is only significant in chemical change. Also, the variation within the group is homogenous.

Table 4.15 A comparison of the conceptions held by grade eight and nine learners on magnetism, chemical change and the environment in the Science Vocabulary Test (SVT)

Variable	Grade 8			Grade 9			F-ratio
	N	Mean	STD	N	Mean	STD	
Magnetism	100	6.36	2.83	150	5.97	3.24	1.51
Chemical Change	100	6.71	2.77	150	5.90	3.20	2.65
Environment	100	5.94	3.21	150	5.65	3.17	0.43

Table 4.15 above shows that grade eight slightly performed better in the three concepts than grade nine with the mean scores (M = 6.36, SD = 2.83), (M = 6.71: SD = 2.77) and (M = 5.5.94, SD = 3.21) respectively. However, the difference between their mean scores is not statistically significant and also the variation within each grade is heterogeneous.

4.1.7 Discussion on the conceptions that grade eight and nine learners hold of magnetism, chemical change and the environment.

Several studies have written a lot about the poor performance of learners in science in South Africa (Makufuta, 2016; Pereina, 2010; Spaull 2013; Kriek & Grayon, 2009).
Nakhleh (1992) also argued that students in all phases of high school usually facea challenge in physical science and their performances have not been encouraging.

Likewise, only a few learners in this study showed some understanding of the three scientific concepts: magnetism, chemical change of substances and the environment,which are regarded as essential topics in Natural Science in the Senior Phase for further study in science at the Further Education and Training (FET) level of education.

A review of the responses above from the interview and the tests,illustrates that the understanding of these learners of magnetism, chemical change and the environment, is weak. The majority of the participants has grasped the idea of the three concepts but could not express themselves well. This findings from this study corroborate the study carried out by Ogunniyi and Taale (2004). The study investigated the relative effects of remedial instruction on 49 grade seven learners' conceptions of heat, magnetism, and electricity; it revealed that a considerable percentage of the learners experienced difficulties with the concepts of heat and heat transfer, magnetism, and electricity and this is probably because of their poor usage of language.The lack of adequate language led to the subjects' inability to express themselves clearly and comprehensibly. Their findings showed that it is difficult for the learners to become discontented with their own worldview in favour of the scientific worldview and also justifies the performance of the learnersusing the instruments for the quantitative analysis of this study. Their level of conception was below what was expected by the interim syllabus for grade eight and nine.

In this study the conceptions of the grade eight and nine learners in the tests on the three concepts are the following:

In grade eight and nine it seems that the girls performed better than the boys in all the tests. Taking into consideration the results from this study, the conceptions of the girls in grades eight and nine of magnetism, chemical change of substances and environment,are probably better than that of the boys in the two grades.

With regard to age, in grade eight the 12 year old group performed better than the other age groups in grade eight while the 14 year old group in grade 9 performed better than the other age groups.Therefore it appears that in the 12 year old group in grade eight and the 14year old group in grade nine, the conceptions of the three concepts is better the other age groups.

Likewise in grade eight and nine, the English speaking group performed better than the Afrikaans speaking and the Xhosa speaking groups. Hence it seems that the English speaking group have a better conceptual understanding of the three concepts considered in this study than the other groups. Furthermore, from the results from the comparison doneof the conceptions that grades eight and nine hold in the three concepts in all the tests, although grade eight learners seems to have a better conception of the three concepts than grade nine,the difference in their mean score in most of the tests are is statistically significant.

With regards to comparison done with grade eight and nine conceptions of magnetism, chemical change of substances and the environment in the three concepts, the participants whose home language is Xhosa are more in number than those whose home language is either Afrikaans or English in grade eight. Thus, language could have contributed to grade nine poor conceptions of the three concepts. Good and Brophy (1994) stated that learners draw on events in their cultural environment in order to have an understanding of the new things that they learn. For example,learners often cover up their misconceptions, which are likely to be unfolded among their peers,parents and other family members while interacting with each other in their own home language.

Another way to look at the problem of language is to suggest that this particular group of learners came from the most previously disadvantaged community in South Africa as a result of the apartheid education system but a closer exploration in this regard would require further studies. The issues of language and associated cultural factors and howthese impat on on learners' performance in science certainly warrant a more detailed examination beyond the scope of the present study. It has become a common phenomenon among learners that researchers could no longer ignore. It has also been noted that language is a barrier to learners' conceptualizatioin in general (Msimanga, Denley & Gumede, 2017).

During the period of time spent with the participants in this study,I also found that grade eight learners' atttitudes towards their studies is more highly commendable than that of great nine.The responses from the interview revealed that the majority of the grade nine learners that participated in this study considered science to be a difficult subject. This corroborates the findings of the following previous studies; Lindahl (2007), in her study of 70 Swedish grades 5-12 learners(with ages ranging between 12 and 16) found that learners' career aspirations and interest in science were largely formed by the age of 13 years. Based on her experience in that, she concluded that it would be very hard to convince older learners to study science.

Lyons (2006) explored the decisions that school learnersmade about taking physics and chemistry courses in high school in urban and rural New South Wales, Australia, and found that learners regarded junior science as irrelevant, uninteresting and difficult, leading them to see no reason for enrolling in senior science courses.However, a few participants have different opinions; their responses suggest that they have a positive perspective towards science and that they are also willing to pursue a career in science. This is where the teaching method and classroom activities could come into play. If one could make the content delivery interesting, then learners' interest in the subject is likely to increase (Lavonen, Angell, Bymen, Henricksen & Koponen, 2007). Bricker and Bill (2008) assert that factors such as background and the ability of the participants, the instructional method used as well as the attitudes of the participants, must be taken into consederation. However, important as the issue of attitude is beyond the scope of the present study. An indepth study of this factor is like to increase the size of the thesis beyond the space allowed. Nevertheless, it is an aspect that I will like to explore in a later study.

The following sections present and discuss the results of the interview that was conducted with the learners in grade eight and nine and the exerpts from the tests written by the learners. The interview was handled in such a way that all the questions were answered by the respondents one after the other. The analysis was done based on the responses received from the participants. Details on the interview are provided in the analysis of the interview below.

In response to the interview on magnetism, the following conceptions of magnetism were held by the grade eight learners. SPL denotes Senior Phase Learner.

Researcher: Can you tell me what you understand by the term magnetism?
SPL 8(1): *Magnetism is a material that attracts other materials.*
SPL 8(2): *Magnetism is something that is a magnet. It attracts something like aluminium. It is a magnet that attracts other objects like metal.*
SPL 8(3): *I will say magnetism is……. (Thinking)……. I have not gotten a concluding word...........ok, it is a relationship between a magnet and anything magnetic.*
SPL 9(1): *It is a magnet that attracts other objects like metal.*
SPL9(2): *Magnetism is something that gets things to attract to it.*
SPL9(3): *Magnetism is iron that attracts others.*
Researcher:Ok, can you mention two examples of appliances that use magnetic force to work
SPL 8(1): *Iron……hmmmm…. I think magnet itself……. (Smiling).*
SPL8(2): *I have no idea.*
SPL8(3)*: Microwave and fridge.*
SPL9(1): *I have no idea.*
SPL 9(2): *No idea.*
SPL 9(3**):** *Speaker and air conditional.*

During the interview, participants SPL 8(2), SPL9(1) and SPL9 (3) had no response to question 2. In addition to the learners' responses to interview on magnetism, the answers derived from the science achievement test on magnetism further revealed the conceptions that the learners hold of magnetism. In order for the researcher to establish what conceptions learners held in terms of the application of magnetism and how the property of a magnet can be destroyed, the learners were asked to answer questions 8 and 9 in Science Achievement Test SAT. The answers given for the questionsare as follows:

Reseacher: List two things in your home that use magnetic force to make them work.

Grade8(24): *Stove and kettle.*

Grade 8(39): *Fridge and stove.*

Grade 8(43):*Fridge and iron.*

Grade 8(45):*Iron and pot.*

Grade 8(46*): Radio and fridge.*

Grade 9(20):*Knife and pot.*

Grade 9(21*): Coin and knife.*

Grade 9 (70):*Microvave and fridge*

Grade 9(10):*Kettle and fridge.*

Grade9(120):*Tv and car's speaker.*

Question :Explain two ways in which magnectic properties of a magnet can be destroyed.

Grade8(41):*When you take it and break it.*

By throwing it away.

Grade 8 (24):*By using hydrochloric acid.*

Grade8(46):*Break it.*

Throw it away.

Grade 9(4):*It can be destroyed by putting water on it.*

Putting it in the sun.

Grade 9(40):*Pour sand on it.*

Put it on fire.

Grade 9(100):*Add boiling water.*

Throw it in the wall.

The learners in the study held different conceptions of magnetism. It seems that there is some evidence that learners' conceptions of magnetism is weak. However,the answers given by the learners on the definition of magnetism seem to suggest that there is a general conception among the learners that magnetic objects have the ability to attract other objects.

In response to the interview on chemical change, the following conceptions were held by the learners on chemical change of substances.

Researcher:What do you understand by chemical change of substances?

SPL8(1): *I have no idea.*

SPL 8(2): *Chemical change is the difference between chemical and particles while physical change is when you change the physical appearance of something.*

SPL8(3)*: I have no idea.*

SPL9(1): *I don't really know*.

SPL9(2): *Chemical change is something that changes by applying some chemical to change itwhile physical change on its own.*

SPL9 (3):*I think chemical change of substances is a chemical that you can use and then change to another object*.

Researcher: Can you please differentiate between a physical change and a chemical change.

SPL 8 (1): *I have no idea.*

SPL8 (2): *Physical change is something that can change on its own, I don't have any idea of the chemical change.*

SPL8 (3): *I have no idea.*

SPL 9(1): *Chemical change is something that changes by applying some chemical to change it while physical change happens on its own.*

SPL 9(2): *Chemical change is the difference between a chemical and particles while physical change is when you change the physical appearance of something.*

SPL 9(3):*I have no idea.*

In order for the researcher to further establish the conceptions of the learners of the chemical change of substances, learners were asked to anwer question 5 in SAT. The anwers given for the question is as follows.

Question: Eno is a '**fruit salt'** that is taken to help with indigestion.When water is addedto ENO powder, the mixtures fizzes.

5.1 What two types of substances do 'fruit salts' contain?

Grade8(40):*Salt and vineger*.

Grade8(37):*Salt and fruit.*

Grade 8(42);*Iron salts and indigestion salts*.

Grade 9(38):*Salt.*

Grade9(19):*Acid and minerals*.

SPL 9(17):*Acid and hydrogen.*

5.2 What substance causes the fizz when fruits salts are added to the water?

Grade8(44): Eno

Grade8(46:*The acid*

Grade8(21): *Acid*

Grade 9(19):*Acid*

Grade 9(9):*Water substances*

Grade9(20):*Acid*

During the interview , particpants SPL (8)1 and SPL (9)1 had no response to question 1 while SPL (8)1 and SPL (9) 3 had no response to question 2. It seems that there is some evidence that learners' conceptions of chemical change of substances is weak. However,the answers given by the participants on what chemical change is and the difference between a physical change and chemical change seem to suggest that at least the participants have the conception that new substances are formed during the chemical change of substances.

In response to the interview on environment the following conceptions were held by the participants of the environment.

Researcher: What is an environment?

SPL8 (1): *Environment is where…… (Stammering)………environment is where people live and it is surrounded by nature.*

SPL (2): *It is evaporation.*

Researcher: Is that all you can tell me about an environment?

SPL8 (2): *It is evaporation and pollution.*

SPL8(3): *Environment is like a nature, where people live……hmmm……………..I can't really explain.*

SPL9(1): *An environment is an area containing life and life habitat.*

SPL 9(2): *Environment is things that live in our surroundings and earth.*

SPL9(3): *Environment is a community where people live.*

Researcher: How can our environment become polluted?

SPL8(1): *It can be polluted by noise, some people make noise and people living around them will not be able to sleep.*

SPL8(2): *Smoke can pollute our environment.*

SPL8(3): *By littering the floor with paper and plastic.*

SPL9(1): *It can be polluted because people just throw paper around and that get our environment dirty.*

SPL(2): *Our environment can be polluted if people litter everywhere with their trash.*

SPL 9(3): *It can be polluted because of the people throwing dirty thing on the street.*

Researcher: What are the disadvantages of a polluted environment?

SPL(1): *People get sick, plant cannot grow because we don't have good water and people get sick.*

Grade8(2): *There will be a lot of diseases, living things will die.*

SPL 8(3): *If we inhale the smoke from the car and from the cigarettes that people smoke, we can have tuberculosis.*

SPL9(1): *Children will get sick; I mean everybody will get sick.*

Researcher: Ho, not only the children……. (Smiling)

SPL9(1): *Yes.*

SPL9(2): *The life of the people living in a polluted environment will be affected.*

SPL9(3): *The life of the people living in a polluted environment will be affected.*

In order for the researcher to further establish what learners conceptions were ofthe environment, the learners were asked to answer questions 12 in SAT. The answers given for the questions are as follows.

Question:12. We breathe out a certain gas which the plants need and the plants give us another gas which we need to be able to live.

12.1 List the gases that we breathe in and the gas we breathe out.

Grade(27):*Oxygen breathe in carbondioxide breathe out.*

Grade 8(22):*Carbon dioxide, oxygen.*

Grade 8(45):*Oxygen.*

Grade 9(35):*We breath in oxygen and breath out carbondioxide.*

Grade 9(3):*Oxygen and carbondioxide.*

Grade 9(6):*Oxygen and carbondioxide.*

12.2 List the gas that the plants take in and the gas they give out

Grade 8(27):*Carbondioxide.*

Grade 8(22):*Carbon dioxide and give out oxygen.*

Grade 8(45):*Oxygen.*

Grade9(35): *They breath in oxygen and take out carbondioxide.*

Grade 9(3):*Carbondioxide and breathe in oxgyen.*

Grade9(6):*Carbondioxide and oxygen.*

From the above responses, it seems that there is some evidence that learners have good conceptions of the environment. The majority of the participants responded well to the question about what the environment is and how it can be polluted.

The performance of the learners in the Science Vocabulary Test that was admistered to them thatused to establish the degree of their conceptions that they hold in science vocabulary also reviewed their conceptions of the three concepts considered in this study and further proved that scientific literacy of the participants in this study is weak. Participants were given passages related to the selected concepts and asked to write the words they are familiar with in the passage and explain and also rewrite the passages in their own words. To the researcher's greatest surprise, the majority of the participants copied the passages word for word (Mpofu, 2006)

Learners acquire knowledge to systematize the concepts in relation to context and then explain it using their own understanding. Considering this, greater priority should be given to the learners' socio-cultural environment during the teaching and learning process (Vygotsky, 1978).This is because learners draw on events in their cultural environment to construe meaning and relate to new ideas (Good & Brophy, 1994). This study draws on this view since teaching and learning is a process and learners come to the school with their own view about their society. The learners draw on events in their context to make meaning of the teaching and learning process. Through this, it is possible that what was seen as problem-solving communication in a learning context, later becomes an individual cognitive process as the learner internalises what had been learnt (Eun, 2011).

Consequently, learners attain new levels of development as they receive mediation from their teachers (Lantolf & Thorne, 2007). This is why learners cannot be separated from their socio-cultural context which is the focus of this study. This implies that learners' success is the product of what the environment offers. It is very important to observe how both teachers and learners draw on their socio-cultural context during the teaching and learning process.

Furthermore, it was discovered that in most cases, the learners guessed or just filled in the blank spaces. This corroborates the finding in the study by Mpofu (2006) which focuses on learners' conceptual understanding of the chemical reaction dealing with fluoridation.The study revealed that in most cases the students guessed or just filled in the blank places.They did not seem to bother about whether their responses were right or wrong.

Also,the findings of a study by Ogunniyi and Mikalsen (2004) to determine learners' ideas about acids, bases and magnetism and the process skills used to perform the task, revealed that the learners are not able to mobilise the necessary conceptual process of decision making and utilize process skills in performing a number of cognitive tasks. This finding also seems to conform to the this study which found that learners do not utilize process skills in performing a number of cognitive tasks.They performed better in the questions where they were asked to clarify or define than the one involving cognitive tasks. Hence, this suggests that the respondents'conceptions of questions involving clarification or definition are better than the ones involving cognitive tasks.

Discussion in terms of the participants' age

In terms of age, in grade eight,the 12year old group's conceptions of the three concepts seems to be better than the other age groups while in grade nine, the 14 year old group appears to have better conceptions of the three concepts than the other age groups. However it was noted that the performance of the learners across the age groups does not differ much.The result on the conceptions that the learners hold of the three concepts in all the tests did not seem to show any significant differences in the performance of the age groups.

This finding seems to corroborate earlier findings in the area, for example Pellizzari and Billari (2012) in their study of age-related differences in academic performance among learners of different ages within the same cohorts using a database of students at Bocconi University, used identification strategies that took into consideration the potential endogeneny of age at school entry by means of an instrumental varriable based on the availability of private pre-schools in the learners' province of birth.Their study revealed that the youngest learners outperform the oldest learners.

Discussion in terms of the participants' gender

Ede (2004) reported that gender needs to be considered for its effect on learner's performance,from a young age. It is remarkable that the findings in this study seem to corroborate with the existing literature which says that girls perform better than boys and vice versa. From this study's results, it appears that the girls perform better than the boys in both grades,although the difference between their mean scores is not statistically significant.This has been found in many studies which includes the following:

Hartley and Sutton (2013),in their studies : A stereotypical threat account of boys' academic under achievement stystematically examined the age at which children develop stereotypes surroundings boys, under achivement at school and how it can be corrected.A total number of 162 British learners in year three who are between seven to eight years old (80 boys and 82 girls) from three primary schools in England participated in the study, since by this age they have developed the meta cognitive abilities needed to be influenced,in order to manipulate the stereotypical threat informing them.Their finding revealed that boys tend to do worse than girls at school.

Furthermore, Legewie and DiPrete (2012), used a quasi experimental research design to explore the gender gap in educational achievement among grade 5 learners in Berlin. Specifically, they investigated the gender differences in the causal effects of peer socio-economic status (SES) as important school resources on test scores.Their findings revealed that boys are more sensitive than girls to the important school resources of classroom SES composition and also broadened our understanding of the well established fact of boys' underperformance .

Also a study carried out by Ogunniyi (1999), in South Africa which investigatedthe problems encountered by South African grades 7-9 learner so as to determine strategies to ameliorate such problems. The study revealed that contrary to the usual pattern the female learners outperformed the male learners in 12 out of 22 acievement tests dealing with various science concepts (including magnetism, chemical change and the environment).

In addition, a study by George (2014) on the Effects of dialogical argumentation instruction on grade 10 learners' understanding of chemical equations in a high school in the Western Cape Province, South Africa. A survey questionnaire, open-end and fixed choice questionnaires and a chemistry achievement test, were used to collect data. The findings revealed that the girls performed better than the boys.

Discussion in terms of the participants' home language

Msimanga, Denley and Gumede (2017) stated that one of the reasons for the persistent poor performance of learners in science is language.With regards to language, the participants whose home language is Xhosa are more in number than those whose home language is either Afrikaans or Xhosa. Those who claim that English is their own language come from all the three cultural groups: White, Black and Coloured. I found that most of the schools use both English and Afrikaans or English and Xhosa.Therefore I decided to consider the performance of the participants based on language rather than the three different racial groups found within the Western Cape.The results from the tests seems to suggest that the English speaking groups in both grades eight and nine performed better than the other groups and this corroborates the study by Ogunniyi (1999) in South Africa which investigated the problems encountered by South Africa Primary and Secondary School learners in science. The findingsrevealed that the English speaking groups performed better than the other groups that participated in the study.

This finding is also in line with Rollnick and Rutherford’s (1996) study on the use of mother tongue and English in learning and expression of science concepts. The study involved groups of primary teacher trainees in Swaziland involving four different combinations of language usage and teaching strategies. The audiotapes of the group work of the participants were analyzed using both English and SiSwati and its effect on conceptual change and frequency of languages changes and social interaction of the group during learning. Their findings revealed that home language is an important tool that learners use to explore their ideas and to eliminate alternative conceptions.

In light of this,Van der Poll and Van der Poll (2007) posit that when learners are required to learn concepts in a second language, they are usually faced with problem of content literacy; the mastering of the content of the subject becomes very difficult therefore the learners’performance is affected negatively. Hence, the importance of language in learning cannot be over emphasized. It serves as a mediator of thought.

4.1.8 Findings regarding research question one

In grade eight and nine it seems that the girls performed better than the boys. Based on their performance, it is evident that in grade nine, the girls’ conceptions of magnetism, chemical change of substances and the environment, is better than that of the boys in the two grades.

With regards to age, in grade 8 the 12 year old group performed better than the other age groups in grade eight while the 14 year old group in grade 9 performed better than the other age groups. Therefore it appears that the conceptions of the three concepts in the 12 year old group in grade eight and the 14year old group in grade nine are better than the other age groups.

Likewise in grade eight and nine, the English speaking group performed better than the Afrikaans speaking and Xhosa speaking groups. Hence it seems that the English speaking group have a better conceptual understanding of the three concepts considered in this study.

4.2 Second Research Question

Second Question: Is there any relatioinship between the learners' age, gender and language and their conceptions of magnetism, chemical change and the environment?

The Pearson's product –moment correlation was run to assess the relationship between grade eight and nine learners' age, gender and language and their conceptions of the three concepts mentioned above in all the tests. Based on the results,the tables 4.16 to 4.20 below show the correlation between learners' age, gender, language and their conceptions of magnetism,chemical change and the environment.

4.2.1 Correlation coefficients between grade eight and nine learners' gender, age and language against their performances on the Science Achievement Test(SAT)

Table 4.16 Correlation coefficient on the Science Achievement Test(SAT)

Grade		Grade 8	Grade 8	Grade 8	Grade 9	Grade 9	Grade 9
Topic		Mag	Chem	Env	Mag	Chem	Env
Number	N	100	100	100	150	150	150
Age	r	-.266	-.240	-.166	-.091	.026	-.118
	Sig.(2-tailed)	.007	.016	.109	.270	.749	.152
Gender	r	-.249	.017	-.042	.320	.139	.168
	Sig.(2-tailed)	.013	.870	.678	.000	.090	.040
Language	r	-.096	.064	.138	.297	.222	.264
	Sig.(2-tailed)	.340	.529	.171	.000	.006	.001

Correlation is significant at 0.05 level(2-tailed)

Correlation critical value: Grade eight 0.205; grade nine 0.195

r= correlation coeficient, n = frequency of the learners

From Table 4.16 above, it can be seen that in grade eight and nine in terms of age the correlation coeffiecients revealed that relationship between the learners' age and gender and their performances in the three concepts is weak. Furthermore, the correlation coefficients is statiscally significant in magnetism and chemical change in grade eight while it not statiscally significant in grade nine in the three concepts.

With regard to gender,the relationship between grade eight and nine and their parformances between their gender is also weak but the correlation coefficients is statiscally significant only in magnetism in grade eight and statiscally significant in grade nine in all the three concept. Furthermore, in terms of language, the relationship between grade eight and nine and their performances between their gender is weak as well. The correlation coefficient is only statistically significant in grade nine.

4.2.2 Correlation coefficients between grade eight and nine learners' gender, age and language against their performances on the Context Test(COT)

Table 4.17 Correlation coefficient on the Context Test(COT)

Grade		Grade 8	Grade 8	Grade 8	Grade 9	Grade 9	Grade 9
Topic		Mag	Chem	Env	Mag	Chem	Env.
Number	N	100	100	100	150	150	150
Age	r	-.012	-.023	.003	-.040	.011	-.051
	Sig.(2-tailed)	.908	.820	.974	.963	.898	.538
Gender	r	.177	.288	.148	.168	.086	-.153
	Sig.(2-tailed)	.079	.005	.142	.040	.299	.062
Language	r	.451	.296	.325	.142	-.078	-.088
	Sig.(2-tailed)	.000	.003	.001	.083	.343	.286

Correlation is significant at 0.05 level(2-tailed).

Correlation critical value: Grade eight 0.205 ; grade nine 0.195

r = correlation coeficient, n = frequency of the learners

Table 4.17 above also revealed that in grades eight and nine the relationship between the learners' age and gender and their performances in the three concepts is weak and correlation coefficients are not statistically significant in both grades eight and nine. Although in term of language, the relationship between their performances in the three concepts and language is also weak but it is statiscally significant in grade eight in all the three concepts.

4.2.3 Correlation coefficients between grade eight and nine learners' gender, age and language against their performances on the Cloze Test(CLT)

Table 4.18 Correlation coefficient on the Cloze Test(CLT)

Grade		Grade 8	Grade 8	Grade 8	Grade 9	Grade 9	Grade 9
Topic		Mag	Chem	Env	Mag	Chem	Env
Number	N	100	100	100	150	150	150
Age	r	-.097	.010	-.023	.144	-.063	-.022
	Sig.(2-tailed)	.388	.918	.819	.078	.441	.788
Gender	r	.151	.189	.215	.040	.044	.066
	Sig.(2-tailed)	.134	.059	.032	.62	.593	.423
Language	r	.319	.306	.235	.007	.057	-.198
	Sig.(2-tailed)	.001	.002	.019	.935	.486	.015

Correlation is significant at 0.05 level(2-tailed).

Correlation critical value: Grade eight 0.205; grade nine 0.195

r = correlation coeficient,n = frequency of the learners

The Table above also revealed that in grades eight and nine in terms of age and gender the relationship between the learners' age and gender their performance in the three concepts is weak and the correlation coefficients are not satistically significant.

With regards to language, the relationship is also weak but the correlation coefficients are statiscally significant in grade eight in all the three concepts and only in grade nine magnetism.

4.2.4 Correlation coefficients between grade eight and nine learners' gender, age and language against their performances on the Picture Test(PIT).

Table 4.19 Correlation coefficient on the Picture Test(PIT)

Grade		Grade 8	Grade 8	Grade 8	Grade 9	Grade 9	Grade 9
Topic		Mag	Chem	Env	Mag	Chem	Env
Number	N	100	100	100	150	150	150
Age	r	.028	.002	-.045	.141	.022	-.026
	Sig.(2-tailed)	.785	.987	.658	.085	.792	.748
Gender	r	.073	-.006	.033	-.097	-.060	.016
	Sig.(2-tailed)	.471	.954	.745	.238	.464	.849
Language	r	.109	.009	.230	-.027	.168	-.040
	Sig.(2-tailed)	.279	.930	.021	.743	.040	.626

Correlation is significant at 0.05 level(2-tailed).

Correlation critical value: Grade eight 0.205; grade nine 0.195

r = correlation coeficient, n = frequency of the learners

Table 4.19 revealed that in both grades eight and nine,the relationship between the age, gender and language of the learners and their preformances in the three concepts is also weak. However, the correlation coefficient is statistically significant in environment in grade eight.

4.2.5 Correlation coefficients between grade eight and nine learners' gender, age and language against their performances in Sciemce Vocabulary Test (SVT)

Table 4.20 Correlation coefficients on the Science Vocabulary Test(SVT)

Grade		Grade 8	Grade 8	Grade 8	Grade 9	Grade 9	Grade 9
Topic		Mag	Chem	Env	Mag	Chem	Env
Number	N	100	100	100	150	150	150
Age	r	.128	.036	-.029	.065	.012	-.047
	Sig.(2-tailed)	.203	.725	.772	.431	.889	.569
Gender	r	.223	.116	.147	.000	.038	.077
	Sig.(2-tailed)	.026	.249	.145	.999	.645	.351
Language	r	.291*	.085	.311**	.197*	.281	.223
	Sig.(2-tailed)	.003	.398	.002	.016	.000	.006

Note: In the above table where the correlation is high, it is indicated by an asterisk(*) and where it is highly significant it is indicated by two asterisks.(**)

Correlation is significant at 0.05 level(2-tailed)

Correlation critical value: Grade eight 0.205; grade nine 0.195

r = correlation coeficient, n = frequency of the learners

The above table revealed that in both grades eight and nine, the relationship between the age, gender and language of the learners and their preformances in the three concepts is weak. However, the correlation coefficients is not statistically significant in age and gender in both grades eight and nine while in term of language,the correlation coefficients are staticically significant in both grades eight and nine except in grade eight chemical change.

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4.2.6 Discussion on correlation between grade eight learners' gender, age and language against their performances in all the test

Newman-Ford, Lloyd and Thomas (2009) reported that gender has only a minor impact on academic achievement. George (2014), in his study, also found that there is no significant differerence between age and gender therefore, they cannot be related to the conception of the learners. This has also been confirmed by the finding in this study.The relationship between the learners that participated in this study and their performance against their age, gender and language is weak. Interestingly,the correlation coefficients in some of the tests in term of language are statistically significant.

With regard to language, similarly,this study also revealead that there is little or no relationship between the correlation coefficient and the learners' performance in the three concepts however, the corelation cofficient is statistically significant in most of the tests unlike in terms of age and gender. This may imply that language has asignificant effect in the performance of the learners that participated in this study.This also concurs with Ogunniyi's (1999) study.

4.2.7 Findings regarding research question two

Based on the grade nine and eight correlation coefficient,the relationship between their age, gender and language and their performance is weak. On the other hand, the correlation coefficients in grade eight and nine is not statistically significant except in few cases in language.

4.3 Summary of the interpretive commentary relative to the two research questions.

The focus of this study is to determine grade eight and nine learners' conceptions of magnetism, chemical change of substances and the environment and how factors such as age, gender and language influence such conceptions. In pursuance of this aim, answers to the following questions were sought:

1. What conceptions of magnetism, chemical change of substances and the environment do grade eight and nine learners hold at selected high schools in Cape Town?
2. Is there any correlation between the learners' age, gender and language and their conceptions of magnetism, chemical change and the environment?

As in earlier studies (e.g. Ogunniyi, 1999) the findings of thie study suggest thatthe conceptions of magnetism, chemical change and the environment held by the grades 8 and 9 learners involved in this study are generally weak.Other studies (e.g. George, 2014; Newman-Ford, Lloyd & Thomas, 2009) find no significant difference learners' conceptions of several science concepts on account of age. Also, in terms of age the younger learners seem to have better conceptions of the concepts than the older ones and with regards to language, the conceptions of the English speaking group as in Ogunniyi's (1999) study is better than the other groups. However, with the exception of a few cases the coefficients of their performance are not statistically significant.

4.4 Overall summary of chapter four

This chapter analyzed the findings of this study quantitatively and qualitatively as indicated at the beginning of this chapter. The major findings that have emerged from the analysis of data are the following:

- Learners who participated in this study have a weak perception of the three concepts; magnetism, chemical change of substances and the environment.
- In both grades, the girls seemed to have better conceptions of the concepts than the boys.
- In terms of age, the younger learners appeared to hold better conceptions of the three selected concepts than the other age groups.
- With respect to language, the English speaking group seemed to demonstrate a better understanding of the concepts than the other groups.
- Based on the statistical analysis of the scores it was found that the differences between the boys and the girls were only significant in terms of language but not in terms of age and gender).
- The relationship between the participants performance in the three concepts and their age, gender and language is weak.However the correlation coefficients is not statiscally significant except in few cases especially language.

Among other issues emanating from the study described above, it seems as in earlier studies that the conceptions of diverse science conceptions held by 8 and 9 learners in question are not much different from what has been reported in the extant literature. The implications of this situation and how it can be addressed e.g. by adopting new instructional strategies certainly deserves a closer attention.

The next chapter will discuss the implications of the findings reported in this chapter for the various stakeholders. This will be followed by some recommendations and conclusion.

CHAPTER FIVE

CONCLUSION,IMPLICATION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents a brief overviewof the implications of the findings in chapter 4. This is then followed by the conclusion, and recommendations for the various stakeholders e.g. educators, subject advisers, curriculum planners and policy makers.

5.1 Overview

This study explored the conceptions that Senior Phase learners (i.e. grades 8 and 9 learners) hold about magnetism, chemical change of substances and the environment relative to age,gender and language. The learners' conceptions of the three concepts were obtained through the five instruments namely: Science Achievement Test (SAT), Context Test(COT), Cloze Test (CLT), Picture Test (PIT), Science Vocabuary Test(SVT) and the Interviews.

A corollary to the aim above has been to discover to what extent the findings can be used to inform practice. This is important because assessment data are supposed to provide the researcher and other stakeholders with useful information about the performance of the learners in question so as to determine what instructional strategies might be adopted in the search to find a lasting solution to the status quo.

In this regard, it would be expected that a successful assessment study would provide the educators with useful knowledge that could be used to enhance the learners' conceptualizations of the three concepts considered in this study as well as others.

5.2 Main findings

This study attempted to provide answers to the two research questions namely, the conceptions grades eight and nine learners hold on magnetism, chemical change of substances and the environment and whether or not such conceptions are related to their age, gender and language.

5.2.1 Question one: What conceptions of magnetism, chemical change and the environment do grades eight and nine learners in selected schools in Cape Town hold on magnetism, chemical change of substances and the environment?

According to section 4.1, majority of the learners display weak conceptions of the three concepts. The same weakness has been shown in the analysis across gender, age and language. Questions where the participants are asked to classify or define terms have higher means scores than those requiring levels of cognitive activity viz: interpretation, application or analysis.

However, in both grades eight and nine, the female students appear to perform better in the three concepts in most of the tests; this could be as a result of their diligence. I found that the females who participated in this study are more active in the class than the males as stated by Woodfield and Earls-Novell (2006) who posited that female students perform better than male students and that this can be attributed to their being more hardworking and their regular attendance in class. As has been shown in the literature, older learners lack the fundamental skills required for effective study (Newman-Ford, Lloyd, & Thomas 2009).

In terms of age, the younger learners perform better than the older learners but the difference in their mean is not statistically different. With regards to language, the English speaking group performs better than the other group and the difference in their mean is statistically different. One of the findings of this study also shows that most of the learners have no interest in science, according to the responses of the learners during the interview. The majority of the learners considered science a dificult subject and they are not even willing to pursue it at FET level.

Furthermore, from the responses of the learners during the interview, it appears that science teachers at some of the schools involved in this study have not been been teaching science as expected and perhaps the learners have not been enjoying the teacher's style of teaching. One of the participants said that the teacher has not been teaching the way the Maths and English teachers teach.It is obivious that students have a negative attitude towards science, however, when this is combined with the educators' inability to teach the subject effectively can have a negative impact on the performance of the learners as in the case of this study.

Ogunniyi (2007a) added that in order to attain cognitive harmonization, it is very important for science to be taught in such a way that learners will understand conventional science in view of what they have been taught and to relate it to everyday experiences. Socio-cultural constructivism further stresses that effective learning cannot be alienated from social happenings as it occurs when children relate to objects, people, and other immediate environments.

5.2.2 Question Two: Is there any correlation between the learners' age, gender and language and their conceptions of magnetism, chemical change and the environment?

According to section 4.2 in this study, in both grades eight and nine the correlation coeffiecients revealed that the relationship between the participants age, gender and language and their performances in the three concepts is weak. However, the correlation coeffiecients is not statistically except in language in few cases. Probyn (2006) reported that learners in South Africa learn science at school in a language medium (English), which is not their own home language and this has caused the learning of science to be a challenge.

Also, Msimanga, Denley and Gumede (2017) assert that language is one of the reasons why learners constantly performed poorly in science.

This finding is in line with the theory that underpinned this study, i.e. socio-cultural constructivism theory as espoused by Vygotsky (1978). That theory stresses the importance of social interaction in the cognitive development of learners. As has been indicated in the analysis, the majority of the learners that participated in this study speak the home languages of Xhosa and Afrikaans, compared to those whose home language is English. Hence, language can be perceived as having a dual character in that it is a carrier of culture as well as a means of communication. Learners face great barriers when learning science in a second, and sometimes third language (Rollnick & Rutherford, 1996). Language is one of the essential features of science in the richness of the words and terms it uses. Hence, from the findings of this study, language could be one of the barriers that caused the learners to perform below expectation.

5.3 Limitations of the study.

Among other limitations, my inability to receive ethical clearance from the University Senate Research Committee on time led to the reduction of data and time. I would have liked to collect data from a larger sample. It took nearly eight months to receive ethical clearance compared to the two days that it took to receive clearance from the Provincial Department of Basic Education. For the same reason, the study was conducted after teaching time, as the normal school time table had to be followed and classes had to be intact: thus this caused a setback in the time scheduled for the collection of data.

Apart from the less than ideal learning environment in these previously disadvantaged township schools such as: the aftermath of the apartheid system of education; the learners' lack of passion and interest in their schoolwork; the learners' poor attitudes towards education in general and so on. Despite these challenges, however, a concerted effort was made to ensure that all the learners participated meaningfully in the exercise. In view of all this, it is still hoped that the findings will be found informative and useful by researchers working in the area.

5.4 Conclusion

Assessment study is one of the effective ways of assessing the extent to which learners understand what they have been taught and whether the teaching is effective or not. In view of the findings reported in the last chapter, it is imperative that there is a rapport between policymakers, curriculum designers and educators through the provision of necessary resources and workshops. In the same vein, when educators are empowered to teach what they have learned, in an encouraging school environment, learners are likely to benefit considerably. In fact, it is in such a context that educational assessments can appraise clearly the learning goals and objectives. All in all, the results from the study indicate that there was:

1. An agreement that the conceptions that the senior phase learners (grade eight and nine) hold of magnetism, chemical change of substances and the environment, is weak.
2. An agreement that there was indeed a connection between language, teaching, learning and assessment; whereas command of the language would facilitate teaching and learning; the lack of a good command of language interfered with understanding and communication; and hence with teaching and learning;implication
3. An acceptance that many respondents had difficulty in answering the surveys due to their inability to understand the English language and the lack of other communication skills necessary for effective learning.

5.5 Implications

The major objective of a curriculum is to stimulate the learners to learn and to enable them to effectively use that learning for their cognitive, moral, emotional, personal, social, physical and psychological development. Several studies have revealed that there is a gap between the objectives of the curriculum and the way it has actually been implemented in the teaching of science (Mustaq & Khan, 2012; Reyes, Brackett, Rivers, Whiten & Salovey, 2012).

However, socio-cultural constructivism theory espoused by Vygotsky (1978) stresses the importance of social interaction in the cognitive development of learners. When learners relateto people and objects around them, they begin to internalize the experiences and to mobilize same to behave in one way or the other. It is the same sociocultural environment that gives them the language with which to think, communicate, and externalize their thoughts, as well as participate in various social activities including learning (e.g., Rollnick & Rutherford, 1996; Ogunniyi, 1999; Vygotsky, 1978). This seems to have been confirmed by the results of this study. The social cultural constructivism must be taken into consideration by curriculum planners and the educator. This could serve as a vital instrument to achieve greater success in teaching of science and to improve the performance of learners in science. Moreover, this method can be applied in other subject areas.

5.6 Recommendations

Based on the findings from the study, the following recommendations are hereby proposed to assist all stakeholders in improving the teaching and learning of science to ensurethe better performance of learners.

1. Government should look into a way of overcoming language as a barrier to learners' conceptual understanding in the classroom by organising workshops for educators (including advisors) and to bring awareness of factors such as language, age group and gender in relation to learners' conception.
2. Policymakers need to ensure that adequate resources and instructional materials are made available for the teaching and learning of science in the school. Christe (2008) posited in his teaching and learning model that "The effective delivery of the curriculum in the clasroom depends greatly on the availability resources, a conducive environment and social interaction".
3. Science lessons must not be taught in abstract. Educators must relate science to the world of learners for easy understanding.
4. Educators must introduce different types of teaching methods and techniques into the teaching and learning process, such as group discussion, counselling, drama, quizzes, debates, exercises, games, group activities, prose and the like to encourage and serve as incentives for the learners in the science class. Teaching using different instructional approaches enriched with relevant instructional materials could evoke the development of a deeperunderstanding

of diverse science concepts (e.g. Ogunniyi, 2007a; Newman-Ford, Lloyd, & Thomas, 2009).

5. Educators should be aware of the socio-cultural environment of the learners in the classroom and be encouraged to use the socio-cultural constructivism approach in teaching school science.

6. The school administrator should ensure that teaching and learning is properly monitored and also ensure that all the materials needed for the effective teaching of science are available in the school.

7. The subject of science should not be handled by educators that are not specialized in science.

8. Learners should also have a role toplay by taking responsibility for their performance and also ensure that they do not allow their environment to affect their performance negatively. Advisably, learners should learn the language of science, so that they can read critically and actively develop an interest in studying science and develop competence in the subject.

5.7 Further research possibilities.

Based on the findings from the study, further research is needed to:

1. Conduct to replicate the present study on a widerscalein South Africa, so that its result becomes valid for the whole country.Since this study was based on a few schools in the Western Cape, its result are at the moment not generalizable. The participants of this study were learners mostly from black and coloured communities, hence, the results reported here might be slightly different in other contexts.

2. Conduct in which more variables should be added to age gender and language so as to ascertain more significant predictors of the academic achievement of science learners.

3. Conduct about the writing habits and abilities of South African students, in order to identify a means of developing the skills which secondary students require to effectively understand English and writequality essays,thereby enhancing their performance in science.

4. Conduct in which various instructional strategies should be deployed to determine how the present anomalous situation concerning learners' weak conceptions of magnetism, chemical change of substances and the environment and perhaps other concepts could be ameliorated.

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Appendices

Appendix A: Permission from UWC Senate Research Committee.

UNIVERSITY of the WESTERN CAPE

OFFICE OF THE DIRECTOR: RESEARCH
RESEARCH AND INNOVATION DIVISION

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03 August 2017

Ms EI Ayano
Faculty of Education

Ethics Reference Number: HS17/6/25

Project Title: Western Cape senior phase learners' conceptions of magnetism, chemical change of the substances and the environment.

Approval Period: 03 August 2017 to 03 August 2018

I hereby certify that the Humanities and Social Science Research Ethics Committee of the University of the Western Cape approved the methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval. Please remember to submit a progress report in good time for annual renewal.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

PROVISIONAL REC NUMBER - 130416-049

FROM HOPE TO ACTION THROUGH KNOWLEDGE

Appendix B: Permission from the WesternCape Education Department

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03 August 2017

Ms EI Ayano
Faculty of Education

Ethics Reference Number: HS17/6/25

Project Title: Western Cape senior phase learners' conceptions of magnetism, chemical change of the substances and the environment.

Approval Period: 03 August 2017 to 03 August 2018

I hereby certify that the Humanities and Social Science Research Ethics Committee of the University of the Western Cape approved the methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval. Please remember to submit a progress report in good time for annual renewal.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

PROVISIONAL REC NUMBER - 130416-049

Appendix C: Science Achievement Test (SAT)

SCIENCE ACHIEVEMENT TEST

Please complete the following by placing X in the appropriate box

Please complete the following items by placing X in the appropriate spaces

Gender	
Female	
Male	

Age	
13years	
14years	
Above 14 years	

Grade	
Grade 7	
Grade 8	
Grade 9	

My Career interests are:

....

My first/home language is:

………………………………

This section consists of selected questions on magnetism, chemical change of substances and environment.

1.Complete the table below by filling in the missing name or symbol of each element.

Name of the element	Symbol of the element
Mercury	_
_	Mg
Sulphur	-
_	Zn
Chlorine	_

2 .An alkaline (basic) solution can be used to neutralize an acid. Name the two substances formed when an acid reacts with an alkaline

2.1..

2.2..

3. Laura was a naughty girl and messed around in her father's garage. She discovered a bottle of hydrochloric acid and started pouring it over a piece of zinc metal that was lying on the ground. After a while she noticed that something was happening to the zinc. Laura spilt some drops of acid onto her hand. What is the first thing she should do? ………………….

4. Magnesium Sulphate (MgSO4).is a compound. A compound is made from two or more elements.

How many elements are found in Magnesium Sulphate?

....

5. ENO is a **'fruit salt'** that is taken to help with indigestion. When water is added to ENO powder the mixture fizzes.

Which two types of substances do 'fruit salts 'contain?

5.1...

5.2…………………………………………………………

6 .The ends of the bar magnet are called poles. What are the names of the two opposite poles?

6.1..

6.2...

7.Not all substances are attracted by a magnet. If one end of a magnet is brought close to the following items which ones will be attracted? Place X in the column of those objects that will be attracted to the magnet.

1	A pencil	
2	Iron nuts and bolts	
3	Plastic mug	
4	A rubber	
5	Paper clip (Zn)	
6	R2 coin	

8. List two things in your home that use magnetic force to make them work

8.1..

8.2..

9 List two ways in which the magnetic properties of a magnet can be destroyed.

9.1...

9.2..

10.What will happen to the two magnets if their unlike poles are brought close together?

…………………………………………..

11. Pollution of the environment is often talked about on TV news, on the radio and written in newspapers as the cause of many sicknesses.

List two things that can be found in our environment.

11.1………………………………………

11.2………………………………………

11.3 State one way in which our environment is polluted.…

……………………………

11.4 List two types of pollution

……………………………

12. We breathe out a certain gas which the plants need and the plants emit another gas which we need to be able to live.

12.1 List the gases that we breathe in and the gas we breathe out

12.1………………………………………

List the gas that the plants take in and the gas they give out

12..2…………………………………………………………..

13. Small bits of dirt which are emitted into the air by car exhausts, fire and factories cause air pollution. After some time, the dirt will settle on the ground, buildings and plants. If you decide to measure the amount of air pollution in your neighborhood, write down at least five steps you will take to measure the amount of dirt on the leaves.

13.1.……………………………………………………………………

13..2……………………………………………………………………

13..3…………………………………………………………………….

13..4……………………………………………………………………

13.5…………………………………………………………………….

Appendix D:Context Test(COT)

A CONTEXT TEST

Please complete the following items by placing X in the appropriate spaces

Gender	
Female	
Male	

Age	
13years	
14years	
Above 14 years	

Grade	
Grade 7	
Grade 8	
Grade 9	

My Career interests are:

....

My first/home language is:

………………………………

Magnetism

The passage below is about magnetism**.** Read the passage carefully and then:

1. Place **X** in the appropriate column to show the terms in the passage that are familiar or unfamiliar to you.

Magnetism is a force that certain kinds of objects called magnetic objects, that can exert force on each other without physical touching. A magnetis surrounded by a magnetic field that gets weaker as one moves further away from the object. A magnetic field is a region in space where a magnet or objects made of magnetic material will experience a non-contact magnetic field. A ferromagnetic material uses magnetic force to attract objects to itself from a distance without touching them. But a ferromagnetic material cannot attract non-magnetic objects to itself.

Terms	**Familiar (know)**	**Unfamiliar (don't know)**
Magnet		
Magnetic object		
Magnetic field		
Non-magnetic objects		
Magnetic force		

2 Explain the following terms in the space below:

Magnet:

....

Magnetic objects:

…..

Non-magnetic materials:

....

Magnetic field:

....

Magnetic force:

………………………………………………………………………………..............................

Chemical Change of substances

The passage below is on the chemical change of substances**.** Read the passage carefully and then:

1. Place **X** in the appropriate column to show the terms that are familiar or unfamiliar to you in the passage.

The decomposition (breakdown) of hydrogen peroxide to form water and oxygen gas is an example of chemical change. The chemical bond between oxygen and hydrogen in hydrogen peroxide are broken and new bonds between oxygen are formed. The reaction between acid and water is an exothermic reaction. This reaction produces a lot of heat and energy which causes the resulting solution to splash on the table. Since water is not as dense as acid, adding it to acid causes a violent or vigorous reaction because the reaction happens only in a small area on the acid surface. But if you carefully add the acid to the water then the reaction is less vigorous and will not splash because there is a larger volume of water to absorb it

Terms	**Familiar (know)**	**Unfamiliar (don't know)**
Hydrogen peroxide		
Hydrogen		
Oxygen		
Chemical bonds		
Exothermic reaction		

2.Explain the following terms in the space below:

Hydrogen peroxide:

……………………………………………………………………………………….

Hydrogen:

…………………………………………………………………………………………

Oxygen:

…………………………………………………………………………………………

Chemical bonds:

…………………………………………………………………………………………

Exothermic reaction:

………………………………………………………………………………………

Environment

The passage below is on the environment**.** Read the passage carefully and then:

1. Place **X** in the appropriate column to show the terms in the passage that are familiar or unfamiliar to you.

The environment is everything which surrounds us naturally and affects our daily lives on the earth. The air we breathe, the water we drink, plants, animals, mountains, rivers and other living things and non-living things around us are part of our environment. A healthy environment occurs when the natural circles go side by side without any disturbance.Any type of disturbance around us affects the environment and may cause harm or cause us to become sick. However, as a result of many scientific, technological and industrial activities, our environment (including water, air, and soil), has become polluted. Undrinkable river water, blocked water drainage systems, a dusty atmosphere and acid rain are good examples of environmental pollution.

Terms	**Familiar (know)**	**Unfamiliar (don't know)**
Environment		
Living things		
Non-living things		
Healthy environment		
Environmental pollution		

2 Explain the following terms in the spaces below:

Environment:

…………………………………………………………………………………………

Living things:

…………………………………………………………………………………………

Non-living things:

…………………………………………………………………………………………

Healthy environment:

…………………………………………………………………………………………

Environmental pollution:

………………………………………………………………………………………..

Appendix E:Cloze Test(CLT)

A CLOZE TEST

Please complete the following by putting X in the appropriate spaces

Gender	
Female	
Male	

Age	
13years	
14years	
Above 14 years	

Grade	
Grade 7	
Grade 8	
Grade 9	

My Career interests are

…………………………

My first/home language

………………………

1. Magnetism

This section consists of a passage on **magnetism** with missing words**.** Read carefully and use the **correct letter** (a to j) of the words in the brackets to fill in the gaps**.**

(a. Magnet b. Steel c. Iron d. Metal e. Electrical f. Ferromagnetic g. Objects h. Direction i. Permanent j. Magnetic)

………..is said to be ferromagnetic if it can be magnetized or attracted by a magnet. If you hold.............very close to a metal object, it may happen that its own .... field will be induced and the object will become magnetic i.e. able to attract things like a magnet. Some metals keep their magnetism for a longer period than others**.** ....loses its magnetism quite quickly if it is taken away from the magnet. On the other hand ....will stay magnetic for a longer time and that is why it is often used for a variety of purposes. In …………..magnets, many domains are lined up resulting in a net magnetic field. …………… made from ferromagnetic materials can be magnetized, for example by rubbing a magnet along the object in one direction. This causes the

………..fields of most or all of the domains to line up in the …………….As a result the object as a whole will have a net magnetic field. Once a …………….. object has been magnetized; it can stay magnetic without being in another magnetic field.

2. CHEMICAL CHANGE

This section consists of a passage on **chemical change** with missing words**.** Read carefully and use the **correct letter** (a-j) of the words in the bracket to fill in the gaps.

(a. Carbon dioxide b. Gases c. Colourless d. Reactants e. Petrol f. Chemical g. Reverse h. Water i. Flame j. Products)

In …………… changes new substances are formed and the process is often difficult to ……………. .It is not always easy to exactly see what has happened during a chemical change. Sometimes the reactants and the products may be difficult to see, especially if they are…………For example when ……….. burns it reacts with oxygen gas (from the air) to produce …………… (Vapour or liquid) and ……………… (gas).So within this reactionthere are two………… and two………. . The reactants are………gases and the water formed as a result of burning may be formed as steam and be difficult to see. Consequently all that would be observed apart from the………. is that petrol is disappearing.

3. ENVIRONMENT

This section consists of a passage on environment with some missing words**.** Read it carefully and use the **correct letter** (a-j) of the words in the bracket to fill in the gaps.

(a. Erosion b. Water c. Climate d. Wildlife e. Soil f. Plants g. Fertile h. Over-grazed i. Desertification j. Distribution)

With the decrease in ………. and high demand for agriculture, Southern African land is becoming less…………..Climate change is also causing an increase in water evaporation from the…………, therefore making farming very difficult in South Africa. The African continent is located in a region where the climate is unpredictable, making it vulnerable to……….change. Also, Southern Africa is generally a semi-arid sub-region and this makes the whole area at risk of……………This situation causes an increase in soil …………, making it difficult for plants to grow. The dry conditions in Southern Africa results in unsustainable food production and endangers…………Through time, soil erosion will result in poor harvesting of …….Southern Africa is already over cropped and ……. and as a result of Africa's vegetation…………

Appendix F: Picture Test (PIT)

PICTURE TEST

Please complete the following by placing X in the correct box.

Gender	
Female	
Male	

Age	
13years	
14years	
Above14 years	

Grade	
Grade 7	
Grade 8	
Grade 9	

My career interests are:

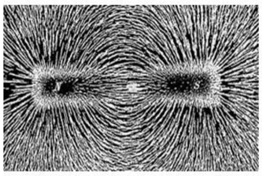
....

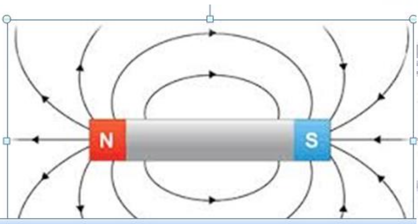
My first/home language is:

………………………

MAGNETISM

The pictures below are about magnetism. Look at the pictures carefully and write what each of them represents.





CHEMICAL CHANGE OF SUBSTANCES

The pictures below are about chemical change of substances. Look at the pictures carefully and write what each of them represents.

ENVIRONMENT

The pictures below are about environment. Look at the pictures carefully and write what each of them represents.

Appendix G: Science Vocabulary Test (SVT)

SCIENCE VOCABULARY TEST

Please complete the following by placing X in the correct box.

Gender	
Female	
Male	

Age	
13years	
14years	
Above14 years	

Grade	
Grade 7	
Grade 8	
Grade 9	

My career interests are:

....

My first/home language is:

………………………

.1 Magnetism

This passage is about magnetism**. (1)** Underline any word in the **passage that you do not understand.**

(2) Read the passage carefully and rewrite in your own words in the space below the passage:

The Earth's magnetic field is very important, for humans and other animals on earth. This is because it protects us from being bombarded (hit) by high energy charged particles (positively charged protons and negatively charged electrons) coming from the sun known as solar wind. When these particles come to the earth, they are deflected or blown away by the Earth's magnetic field. This is to prevent them from falling on us and other organisms (living things) and harmingthem. Just as like poles or identical poles of two magnets repel each other, so does the earth's magnetic earth repel the charged particles coming from the sun.

………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………

2. CHEMICAL CHANGE OF SUBSTANCES

The passage below is about chemical change of substances**.(1)**Underline any word in the **passage that you do not understand.**

(2)Read the passage carefully and rewrite in your own words in the space below the passage:

For any chemical equation (in a closed system) the mass of the reactants must be equal to the mass of the products. In order to make sure that this is the case, the number of atoms in the products must be equal to the number of atoms of the reactants. The energy changes that take place during a chemical reaction are much greater than those that take place during a physical change in matter. During a chemical reaction, energy is used up in order to break bonds and then energy is released when the product is formed.

....

....

....

....

....

....

3. ENVIRONMENT

The passage below is about environment. (1)Underline any word you do not nderstand in the passage.(2)Read the psaasage carefully and rewrite in your own words, what the is trying to exlain in the space below the passage:

Coal minning is one of South Afrika main enargy sources. However mining coal has a huge negative impact on the land, water, air and soil quality in the area.Acid drainage is the result of excess coal mining.For instance, Sulphuric acid is slow, the time it takes for it to be neutrilized is equally as slow.When pure water is released from the rock masses that broken through mining it is mixed with sulphuric acid causing the water to be polluted.

....

....

....

....

....

....

Appendix H: **Letter to the Principals**

LETTER TO THE PRINCIPAL

RE: FIELDWORK FOR MED STUDY IN EDUCATION

I wish to seek for permission to perform a research study at your school. I am currently enrolled for my MED study at the University of the Western Cape. The research study will include fieldwork in Senior Phase learners' classes. All information gathered shall only be used for research purposes. The name of the school and the learners involved shall not be disclosed to anyone. Fifty learners from theSenior Phase will be selected and will be asked to complete the following research instruments: science achievement test, science vocabulary test, cloze test, context test and picture test. Focus group interviews will also be done with 5-10 learners. The research will take place after the normal school hours so that the school timetables will not be interrupted. Permission will be sought from the learners and their parents for participation in the study and to be recorded. For further information kindly contact my supervisors Dr. Cynthia at 021 959 3687, Prof Meshach Ogunniyi at 07038605130 or the research student at 0604084980.At the end of my data analysis, I will give the summary report of my findings to the school. For ethical consideration in data gathering, the stamp of the school and the signature will be needed for the purpose of confirmation of consultation and permission by the school management.

Kind Regards

ElizabethIdowuAyano

Appendix I: Letter of information to the learners regarding the survey

LETTER OF INFORMATION TO THE LEARNERS REGARDING THE SURVEY

I am a master's student in Education at the University of the Western Cape and I have been granted permission by the Western Cape Education Department to conduct a research exercise at various schools in the Western Cape. The purpose of the research is to explore the conceptions of Senior Phase learners of magnetism, chemical change of substances and the environment. In order to do the investigation, your permission is required to participate in the research. The name of the school and the learners involved shall not be disclosed to anyone by the researcher. You are also free to withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits. The research has been planned for 30minutes and it will take place after school hours in order not to interrupt the school timetable. You will be asked to complete some research instruments. These research instruments include; Science Achievement Test, Cloze Test, Context Test, Science Vocabulary Test and Picture Test.

Kind Regards

Elizabeth Idowu Ayano

Appendix J: Assent form for learners to participate in the survey

ASSENT FORM FOR LEARNER'S PARTICIPATION IN THE SURVEY

The study has been described to me in language that I understand. Any questions I may have about the study have been answered. I understand what my participation entails.I agree to participate of my own choice and free will and I may withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits. I also understand that the name of the school and the learners involved shall not be disclosed to anyone by the researcher.I hereby agree to participate in the survey.

Participant's full name: ____

Participant's signature: ____

Date: ____

Appendix K: Consent letter to the parents for learner's participation in the survey.

CONSENT FORM TO THE PARENTS FOR LEARNER'S PARTICIPATION IN SURVEY.

I am a master's student in Education at the University of the Western Cape and I have been granted permission by the Western Cape Education Department to conduct a research exercise at your child's school.The purpose of the research is to explore the conceptions of Senior Phase learners of magnetism, chemical change of substances and the environment. In order to do the investigation, your permission is required to allow your child to participate in the survey. The research has been planned for 30 minutes and it will take place after school hours in other not to interrupt the school timetables.The participation of your child is of his/her own choice and free will and the identity of him/her will not be disclosed to anyone by the researchers.He/she may also withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits.Kindly complete the following if you are willing to allow your child to participate in thesurvey.

Parent's full name: ______________________________

Parent's signature: ______________________________

Date: ______________________________

Appendix L: Consent form to the parents for learner's participation in focus group interview.

CONSENT FORM TO THE PARENTS FOR LEARNER'S PARTICIPATION IN FOCUS GROUP INTERVIEW.

I am a master's student in Education at the University of the Western Cape and I have been granted permission by the Western Cape Education Department to conduct a research exercise atvarious schools in the Western Cape.The research has been planned for a period of 30 minutes and it will take place after school hours in order not to interrupt the school timetables.The participation of your child in the focus group interview is of his/her own choice and free will and the identity of him/her will not be disclosed to anyone by the researchers.

He/she may also withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits. The participants in the Focus group will not disclose the identity of other participants or any aspects of their contributions to members outside of the group.Kindly complete the following if you are willing to allow your child to participate in the Focus group interview.

Parent's full name: ____

Parent's signature: ____

Date: ____

Appendix M: Letter of information to the learners concerning the Focus group interview

LETTER OF INFORMATION TO THE LEARNERS REGARDING THE FOCUS GROUP INTERVIEW

I am a master's student in Education at the University of the Western Cape and I have been granted permission by the Western Cape Education Department to conduct a research exercise at your school. The purpose of the research is to explore the conceptions of Senior Phase learners of magnetism, chemical change of substances and the environment. In order to do the investigation, your permission is required to participate in the Focus group interview. The name of the school and the learners involved shall not be disclosed to anyone by the researcher. You are also free to withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits. The interviews have been planned for 30 minutes and it will take place after school hours in order not to interrupt the school timetable.All information shared during the focus group discussion will be kept confidential by the researcher. Participants are also expectedto uphold the confidentiality of the discussions in the focus group by not disclosing the identity of other participants or any aspects of their contributions to members outside of the group.

Kind Regards,
Elizabeth Idowu Ayano

Appendix N: Focus group confidentiality binding form

FOCUS GROUP CONFIDENTIALITY BINDING FORM

PROJECT TITLE: Western Cape Senior Phase Learners'Conceptions of Magnetism, Chemical Change of Substances and the Environment.

The study has been described to me in language that I understand. Any questions I may have about the study have been answered. I understand what my participation entails and I agree to participate of my own choice and free will. I understand that my identity will not be disclosed to anyone by the researchers and that I may withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits. I also understand that confidentiality is dependent on participants in the Focus Group maintaining confidentiality. I hereby agree to uphold the confidentiality of the discussions in the focus group by not disclosing the identity of other participants or any aspects of their contributions to members outside of the group.

Participant's full name: ____

Participant's signature: ____

Date: ____