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EXAMINING THE TEACHING OF NATURAL SCIENCES CONCEPTS TO ENGLISH SECOND LANGUAGE SPEAKERS IN SELECTED PRIMARY SCHOOLS IN THE EAST LONDON EDUCATION DISTRICT

BY

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DECLARATION

I, Nomaroma Kumanda, declare that this dissertation submitted for the Degree of Doctor of Philosophy in Education at the University of Fort Hare, is my own work and has not been submitted by me or anyone else for PhD at this or any other tertiary education institution.

I also declare that all the sources used or quoted have been indicated and acknowledged

Signed: ***Kumanda Nomaroma*** Date: 03/01/19

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I, Nomaroma Kumanda, student number 201203920, hereby declare that I am fully aware of the University of Fort Hare Policy on Plagiarism, and that I have taken every possible precaution to comply with the regulations pertaining to this policy

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ABSTRACT

The study sought to examine the teaching of Natural Sciences (NS) concepts to English second language speakers in selected primary schools. Grade 7 was chosen for the investigation as it precedes the last class at primary school. The researcher investigated the teaching and learning of Natural sciences concepts. A mixed method design was used. The research questions focused on the teaching of NS, learner-centred strategies used, challenges encountered, strategies employed by teachers when teaching NS, and the implications for science education.The purpose was to examine the teaching of Natural Sciences concepts to English second language speakers in selected primary schools in the East London Education District. Data were collected from grade 7 teachers and learners in selected township schools in East London, by means of semi-structured interviews, questionnaires and focus groups. Semi-structured questionnaires were administered to teachers and learners, individual interviews were conducted with NS head of department, focus group and interviews were held with grade 7 NS learners. Quantitative and qualitative data were independently analysed and merged at the interpretation stage for triangulation of results. The questions were grouped according to their themes. The researcher's findings revealed that teachers linked the teaching of NS concepts by showing the teaching skills. Teachers used code-switching for learners to understand the scientific concepts for positive attitude to improve the learner performance. Teachers experienced problems using English as a Language of Learning and Teaching (LoLT) while teaching NS concepts, teachers' understanding of NS influenced their ability to implement of transformational curriculum, but learners did not benefit much when learning science in English Language and those policies were designed by the Department of Education without teacher involvement. The study concluded by noting that It emerged that teachers and learners experienced difficulties in teaching and learning of the NS concepts.

DEDICATION

This work is dedicated to my late Kumanda family Mr Thanduxolo (father), Mrs Adelaide (mother) and Phiwayinkosi (brother). This, I know would have made you proud.

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I wish to acknowledge all the people who gave me their support and guidance during the period of this study.

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LIST OF ACRONYMS AND ABREVIATIONS

CAPS CURRICULUM ASSESSMENT POLICY STATEMENT

CD CODE-SWITCHING

DBE DEPARTMENT OF BASIC EDUCATION

EFAL ENGLISH FIRST ADDITIONAL LANGUANGE

ESL ENGLISH SECOND LANGUAGE

FAL FIRST ADDITIONAL LANGUAGE

HOD HEAD OF DEPARTMENT

LIEP LANGUAGE IN EDUCATION POLICY

LOLT LANGUAGE OF LEARNING AND TEACHING

LUSSI. LEARNERS' UNDERSTANDING OF SCIENCE AND SCIENTIFIC INQUIRY

MMR MIXED METHODS RESEARCH

NS NATURAL SCIENCES

OED OXFORD ENGLISH DICTIONARY

PCK PEDAGOGICAL CONTENT KNOWLEDGE

SA SOUTH AFRICA

SES SOCIO-ECONOMIC STATUS

SMT SCHOOL MANAGEMENT TEAM

TIMSS TRENDS IN INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

WEF WORLD ECONOMIC FORUM

ZPD ZONE OF PROXIMAL DEVELOPMENT

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RESEARCH CONTEXT AND BACKGROUND

1.1 INTRODUCTION

Learning science currently requires the student to learn science concepts in English. If learners have to learn science in a language which is not their mother tongue, they need to first master the language of instruction and then the science concepts. The mother tongue of the learners in East London is mainly IsiXhosa but science is taught in English. Therefore, learners have a task to first understand English and then conceptualize science in their home language. Apart from the language barrier, learners' socio-cultural background also affects their understanding of science concepts (Chang & Wu, 2007).
The science teacher should therefore, understand issues of language and learners' background for the effective teaching of science concepts. Science education involves providing students with additional, carefully chosen experiences, structured to allow them to continue developing their ideas towards those that are more scientifically accurate (Chang & Wu, 2007).

To ensure that there is effective teaching and learning of science, it is the teacher's role to find ways to deal with language problems that may hinder learners to conceptualise science concepts. Wilson (2009) points that, without a clear understanding of both the second language and science concepts, students may have challenges in understanding the subject. Teaching science in English to English second language speaking learners negatively affects the learners' performance (Ferreira, 2011). Ferreira, (2011) also points out that learners do not only experience challenges with English as a language, but with science concepts as well.

Wellington and Osborne (2001) state that "science education involves dealing with familiar words and giving them new meaning in new contexts" Language barrier is viewed as one of the main factors negatively affecting the teaching and learning of science in African school (Wellington & Osborne, 2001). This study examined the teaching of natural sciences concepts to English second language speakers.

1.2 BACKGROUND THE STUDY

Internationally, the teaching of science concepts in European schools, such as in Netherlands, France and Belgium, is meant to stimulate learners' interest in science at a young age (Science on Stage, 2006). Interest in science leads many learners to study science and take up science related careers after school. According to Akerson (2009) basic understanding of science is considered a necessary skill for every European citizen. Concerns about low student performance in basic skills, as revealed by international surveys, led to the adoption of some approaches to science teaching in European schools. Science on Stage (2006:7) states that natural science are empirical and thrive on experiments. The role of the experiment in teaching science concepts involves a high level of didactic and methodological requirements.

In the United States of America, it observes that English second language learners experience serious challenges in learning science concepts because science has a complex language that is difficult even for English native speakers to learn (Herr, 2007). Visualisation is a strategy which is encouraged to assist such students to learn scientific language. Visualisation entails promoting visual literacy, which is the ability to evaluate, apply, or create conceptual visual representations. To promote this visual literacy, science teachers use scientific diagrams, pictorial riddles, flow charts, mind maps, concept maps science videos often introduce a variety of new terms and concepts. In such a strategy, learners are able to create a visual image of the concept they are studying, and this enhances their understanding.

Watters and Diezmann (2007) call for the use of video instruction in teaching science terminology to learners. Their argument is that, before teaching a new science topic, the teacher should attempt to introduce new and unfamiliar terms, which students were using in the lesson. Video instruction becomes a very powerful tool as it exposes students to sounds and images, which stimulate learners' emotional and intellectual curiosity. The difficulty of learning new words and terms decreased, and learners understand new language better.

In the United States of America, Neuman (2011) it was characterised by generations of dependence on traditional approach. Information is presented to the students in lecture format and assigned readings in a textbook supplemented by demonstrations and, possibly, "cookbook" laboratory activities. In the US students were responsible for solving problems after the teacher showed them examples of how the type of problem was solved. After that, different ideas on teaching physical science emerged. Various programs developed, courtesy of funding from the National Science Foundation. These programmes served as a bridge to the generation teaching style, meant to promote student centered learning rather than the teacher-centered model. Teachers needed additional professional development to employ the constructivist strategies in their classes. A generation emerged, using cognitive research-based materials to support constructivist learning. In addition, they incorporated technology for collecting and analysing data and conducting simulations to complement student development of cognitive understanding of science concepts. These changes in the teaching of physics pose challenges for the preparation of physical science teachers. Many states have implemented a standards-based science curriculum in grades that often based on the *National Science Education Standard (*Neuman, 2011).

In 2007, Malaysian researchers posted a study about the problems and challenges of learning through a second language; the case of teaching of science and mathematics in English in the primary schools. Tan and Tan (2008) look at some of the theoretical constructs pertaining to choose of language used, as well as learning through a second language. These theoretical constructs offer some insight on the implementation of the policy of teaching science and mathematics in English in the Malaysian primary schools. They highlight the attendant strengths and weaknesses. In 2003, the Malaysian government introduced English as a language of instruction to teach science and mathematics at all levels of education, implemented in stages (Tan & Tan, 2008).

In China, the study says the learning-by-doing approach to science education deals with two main aspects; learning to speak and write the language of science and meeting the demands of learning science in languages other than the mother tongue or home languages (Wu Yei, 2005). In China, Wei (2003) proposes two main types of teaching methods to improve teach science concepts. The first focuses on the sense of second language-based exercises and activities, which is the main target of Communicative Language Teaching (CLT). In addition, language has received much attention in teaching science concept as the terms show. The unplanned strategies refer to occasions when words are acquired incidentally and accidentally in class when students request meanings of the word, or when the teacher becomes aware of any relevant words to which attention needs to be drawn. The second focuses on the development of learners' own second language associations. Wei (2003) mentions that teachers need to include an element of uncertainty or flexibility into classroom activities to support the development of learners' own built-in lexical syllabus.

In Spain, the Spanish Foundation for Science and Technology (FECYT) show the divesity of a wide range of science education (Goddard & Melville, 2001). The early work in science education research often focuses on the language demands of learning science and continues to develop into multi-modal ways that students learn science. Scientific language has specific demands (Wereiams, 2006). There is an extensive amount of language to learn, and studies show that the language demands of some secondary school science programmes is greater than that of second-language programmes (Wereiams, 2006). Too much is expected of students, particularly where the language of instruction is not the same as the students' home language (Setati,2011). Science is generally considered difficult, and does not stimulate interest, especially to the students that learn in second languages. There are drastic and progressive reduction in secondary student's choices related to scientific options. Science teachers play an essential role in the scientific education and improvement of students' motivation and learning. New strategies and plans for initial and in-service teacher training are necessary (Goddard & Melville, 2001).

In Africa, the teaching of Science concepts is also taken seriously in most countries. However, there are still challenges encountered at the implementation stage. Science curricula is often reviewed and revised to ensure that scientific skills and knowledge offered is relevant to the economic needs of a country. One of the observers Ajaja (2009) in Nigeria, state that sciences are taught in school subjects such as Biology, Chemistry and Physics. Some of the major objectives in teaching science are to ensure that learners acquire skills in the scientific method and have 'clear explanations for societal issues through increasing interest in science literacy and societal goals. Learners are expected to apply knowledge and skills acquired in science to real life contexts. Ajaja (2009) further notes that the teaching of science concepts in some Nigerian schools is negatively affected by teachers' reliance on the method in science teaching.

In Rwanda, Seroto (2012) conducted a study on the influence of Language of Instruction on learning, where learners should be helped to learn and master the language in which the learning materials written, which is English. Learners needed to master science concepts expressed in English as a foreign language and had to find ways to facilitate learning of the technical language that was a prerequisite to understanding science concepts. Airey (2009) states the importance of language in Science learning, where instruction in a second language presents two challenges. First, it is a challenge to understand the language itself, and second, to understand foreign concepts presented in scientific language.

Three Ghanaian researchers Anastácio, Carvalho and Cléments' (2008) examined the application of the language of instruction policy in Science teaching. The study investigated the coping strategies of lower primary teachers in their use of mother tongue in teaching Science concepts. They believed that the mother tongue plays a crucial role in learning during the early years. In Ghana, Science education is a core component of the school curriculum. Natural sciences syllabus and Science education aims at equipping learners with the necessary process skills and attitudes that provide a strong foundation for further study in Science. To achieve this aim, teachers need to use effective teaching methods in their teaching, as effective teaching makes great difference (Acquah, Eshun & Broni, 2014).

In South Africa, using investigations and practical work to explain science concepts makes learning simplified as it moves from the concrete to the abstract. It is therefore, critical that the concrete foundations, on which abstract concepts are built, are accurate (Shaffer, 2007). Scientific investigations provide such foundations through observing concrete objects and proceeding to other process skills such as classifying, imagining, interpreting and extrapolation, to name a few. Ideally, these skills are obtained by doing practical work, and through observation, concept formation occurs. This requires going beyond the textbook and using the classroom situation to its full advantage, boosting interaction between learners by doing demonstrations, hands-on activities and group work (Schaffer, 2007).

In South Africa, Mammino (2009) investigated the language-related difficulties in learning science concepts. Mammino underlines documents and the importance of language mastery for students pursuing science or engineering careers and suggests that the development of language mastery to high levels is needed for the generation and communication of scientific information, is required to become a relevant component of science and technology education; and discusses some possible implementation pathways. Mammino (2009) also mentions that language is the fundamental tool for communication and has a fundamental role in the development of abilities in other communication tools like visualisation or the use of symbols. In South Africa, Setati (2011) researched English as a language of learning and teaching science in rural secondary schools. Findings were that deficient performance in Science may be due to learners' misunderstandings of questions (Setati, 2011). The learning of Science requires a learner to be proficient in the language of learning and teaching, as well as in the language of Science; that is, acquiring the specialised concepts that characterise the Sciences. Setati, Adler, Reed and Bapoo (2002) state that most South African teachers, especially in secondary schools, work in classrooms where English is officially the language of learning but is not the first language of either the teachers or the learners. Taylor (2008) also points out that after poverty, language, and in particular proficiency in the medium of instruction, is the largest single factor that affects learner performance at school. English (second language) as a subject, has the largest number of learners, and learners do not only communicate in class in a second language, but have to use it as medium for learning all their other subjects (Taylor & Prinsloo, 2005). Teachers are therefore, faced with the double challenge of teaching a particular subject in English while learners are still learning the language. Setati (2011) mentioned that educational and non-educational policy groups acknowledge challenges faced by science learners in the learning of science using English as medium of communication. This is possible because the study investigated the teaching of natural sciences concepts English as a medium of instruction in the learning.

This research focuses on teaching Natural sciences concepts by grade 7 teachers to English second language speakers in selected primary township schools in East London education district. In Curriculum and Assessment Policy Statement (CAPS), there are strands pointed by Coleman (2011) which suggest that second language learners acquire language content when they challenged cognitively with contextual and linguistic supports. The following concepts are taught in grade 7 using English language as medium of instruction:

- life and living such as biodiversity sexual reproduction variation;
- matter and materials such as properties of materials, separating of mixtures, acids, bases and neutrals and introduction to the periodic table elements;

- energy and change such as potential and kinetic energy heat transfer, insulation and energy saving, energy transfer to surroundings; and
- planet earth and beyond such as the national electricity supply system, relationship of the moon to the earth and historical development of astronomy (Department of Basic Education, 2011).

The study sought to establish how science concepts, drawn from the above stated strands, are taught to English second language speakers in selected primary schools in the East London education district.

1.3 STATEMENT OF THE PROBLEM

Teachers face considerable challenges when teaching science concepts, and challenges are mainly due to limited subject matter knowledge in a science area. This requires the development of the teachers' pedagogical content knowledge which is crucial in lesson preparation and in the way science teaching (Howie, Scherman and Venter, 2008). Studies in South Africa have shown that the use of English as medium of instruction in science teaching and learning impacts negatively on the teaching and learning of science to English second language learners (Setati, 2011). Use of English negatively affects learners' understanding of science concepts, their participation in science teaching and learning, and response to assessment tasks (Setati, 2011). Brock-Utne (2000) observes that assimilation and processing of abstract concepts is often hindered by use of a foreign language.

The Trends in International Mathematics and Science Study (TIMSS) in 2011 and 2015 showed that grade 8 learners in South Africa performed badly compared to their counterparts in participating countries. South Africa was considered scientifically illiterate (Howie, et al., 2008). Howie et al., (2008) states that South African students performed poorly compared to their counterparts in the region in TIMSS assessments, and this was attributed to language challenges in understanding science concepts and processed. Naidoo and Muthukrishna (2014) say that when TIMMS results for 2011 were analysed nationally, it was observed that in Natural Sciences, all the provinces performed better than the Eastern Cape. The province ranked ninth out of the nine provinces, in Science performance in the 2012 examination. Howie et al., (2008) says English language proficiency is a strong predictor of learners' success in Science. In these international assessments, South African learners were considered scientifically illiterate (Howie et al., 2008). Reddy (2006) states that in South African schools, learners with limited English-language proficiency have serious challenges in understanding science concepts, which results in them performing poorly in science.

The World Economic Forum (WEF) Report of 2015 ranks the quality of SA science education low at 130 out of 143 countries. In addition, in the South African public-school system, low teacher effort considered one of the most serious problems leading to poor science results and this exacerbated by lack of teacher content knowledge and pedagogical skills required for teaching the curriculum effectively (Taylor, 2011). This could explain why learners did not perform well in Natural Sciences at grade 7 level. This study sought to examine the teaching and learning of Natural Sciences concepts involving English second language learners in selected primary schools in East London education district.

1.4 RESEARCH QUESTION

1.4.1 Main Research Question

How are Natural sciences concepts taught to English second Language learners in selected primary schools in East London Education District?

1.4.2 Sub Research Questions

1. How do teachers link the teaching of Natural sciences concepts to learners' prior knowledge?
2. What learner-centred strategies are utilised in the teaching and learning of Natural sciences concepts?
3. How do strategies employed by teachers assist learners in learning Natural sciences concepts?
4. What challenges do teachers and learners encounter in the teaching and learning of science concepts?
5. What are the Science implications for education?

1.5 PURPOSE OF THE STUDY

This study aimed to examine the teaching of natural sciences concepts to English second language speakers in selected primary schools in the East London Education District.

1.6 OBJECTIVES OF THE STUDY

The study sought to:

a. investigate how teachers linked the teaching of Natural sciences concepts to learners' prior knowledge;
b. establish how learner-centred strategies are utilised in the teaching and learning of Natural sciences concepts;
c. explore how strategies employed by teachers assist learners in learning Natural sciences concepts;
d. examine challenges teachers and learners encounter in the teaching and learning of science concepts; and
e. assess the science implications for education.

1.7 SIGNIFICANCE OF THE STUDY

The results of the research would be disseminated to the various stakeholders within the Department of Education. Firstly, the provincial officials responsible for curriculum design might benefit in the sense that they would design Science programmes which accommodate linguistic challenges faced by second language teachers in teaching natural sciences to English second language speakers**.** Senior primary school Science educators may benefit because the study may shed valuable information on the nature of learners' learning strategies, thus giving direction for educators to device some form of academic intervention programme to improve learners' chances of successfully completing their studies (Reddy, 2006). This study might also serve as a basis for other related research that might affect natural sciences performance in schools. This might assist the English second language speakers to develop and acquire strategies with which to direct their own learning (Rollnick, 2000). This study would contribute to the body of knowledge about primary school Science learners' learning experiences. The significance of this study had implications for Science education, not only in South Africa, but also in Africa as a whole, where the ex-colonial languages are still being used as languages of learning and teaching. The study might suggest guidelines and teaching methods that could be used by teachers to better facilitate learning and teaching, thereby, improving learners' academic performance and throughput.

1.8 DELIMITATION OF THE STUDY

This study was restricted to IsiXhosa home language learners in primary schools falling under the East London Education District. The study focused mainly on how Natural sciences concepts are taught to English second language speakers in selected primary schools in East London education district**.** The study was restricted in terms of the homogeneity of the population in that all learners were black and shared a uniform first language IsiXhosa background.

1.9 DEFINITION OF KEY TERMS

This section provides definition of key terms:

1.9.3 Home language:

Home language refers to a language in which a child is competent. This might mean that it is the language that child acquired first from their parents or family members (Ball, 2010). In this study, this term refers to the language that is frequently spoken at home by the teachers and learners.

1.9.4 Language proficiency:

According to the DBE (2010), language proficiency is the level of competence at which an individual is able to use a language for both basic communication tasks and academic purposes. In this study, language proficiency is the level of competence at which an individual is able to use a language for both basic communication tasks.

1.9.5 Second language:

According to the Oxford English Dictionary (OED), a second language is a language spoken in addition to one's native language; the first foreign language one learns. Students who is in the process of actively acquiring English, and whose primary language is one other than English. A learner's self-confidences are weakened because home language cannot be used for learning. These students often benefit from language support programs to improve academic performance in English due to challenges with reading, comprehension, speaking, and/or writing skills in English. Fischler (2005) defines it as any language that is acquired after one's first language. The researcher examined the use of English as a second language in this study.

1.9.6 Educators

Persons, who teach, educate and train other persons and in this study, this term replaces teachers. For the purpose of this study, the term educator is specifically used to refer to science teachers in schools.

1.9.7 Teaching

According to Heugh (2006) teaching is seen as creating opportunities for learning to take place, as well as the process of helping learners to learn. Teaching is the learning process of experience that changes the individual life. This study examined the teaching of natural sciences concepts to English second language speakers.

1.9.8 Concepts

Van Staden (2003) defines concepts as a type of filing system in the brain under which experiences, facts and knowledge are sorted for later use. There are countless categories of concepts, such as subject-specific concepts, scientific concepts, and culture-specific concepts (Van Staden, 2003). This study focused on the Natural sciences concepts.

1.9.9 Natural sciences

Collins English Dictionary (2009) defines Natural sciences as a science or knowledge of objects or processes observable in nature in biology, chemistry and physics. In this study, natural sciences refer to a subject in the SA education system in which learners learn combined science.

1.10 CHAPTER DEMARCATIONS

The study was organised into five chapters as follows:

Chapter 1: Introduction and background

Chapter 2: Theoretical Framework and Literature Review

Chapter 3: Research Methodology

Chapter 4: Data presentation and analysis

Chapter 5: Discussion of Findings

Chapter 6: Summary, Conclusions and recommendations

1.11 ORGANISATION OF THE MONOGRAPH

In the following paragraphs, the researcher presents the structure of the thesis by describing main themes of the chapters.

1.11.1 CHAPTER ONE: INTRODUCTION AND BACKGROUND

The first chapter was the introduction chapter, which explored the background of the study and the reasons to why the study was done. The purpose of the study, objectives of the research and the research questions were presented in this chapter.

1.11.2 CHAPTER TWO: THEORETICAL FRAMEWORK AND LITERATURE REVIEW

This chapter provided a broad theoretical framework and literature review on the use of a second language in the teaching of Natural sciences Concepts. It provided the main conceptual framework for this study, and the phenomenon of the language of learning and teaching and learning of Natural sciences concepts. A literature review is infused in this second chapter to put the research problem into context and perspective.

1.11.3 CHAPTER THREE: RESEARCH DESIGN AND RESEARCH METHODOLOGY

This chapter dealt with the Research Design and Methodology. It described the study methodology, data collection procedures and data analysis strategies. In this chapter, all the research methodological processes and procedures were explained and justified.

1.11.4 CHAPTER FOUR: DATA PRESENTATION, INTERPRETATION, ANALYSIS AND DISCUSSION

This chapter presented results of both the quantitative and the qualitative components of the study, in line with the mixed methods approach followed in the study. Results are presented in answer to the set sub-research questions. Qualitative results were presented to complement the quantitative ones, and both sets of results are synchronised to give a holistic picture of issues under investigation.

1.11.5 CHAPTER FIVE: DISCUSSION OF FINDINGS

In chapter five, the results reported in chapter four were interpreted and discussed. Presentations of the findings gathered from the field are made. The discussion of findings follows the order of objectives of the study.

1.11.6 CHAPTER SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Recommendations and implications for both future research and practice were outlined in this chapter. This chapter also gave a summary of the study.

1.12 SUMMARY

In the opening chapter of this study, the researcher started by showing the background of the study internationally to nationally. The chapter then discussed the problem statement, research questions, study purpose, objectives, significance, and delimitations of the study. This helped locate the study. The second chapter discusses the theoretical framework which informs the study and reviews the literature that is related to the study

CHAPTER TWO

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 INTRODUCTION

The first chapter discussed the research problem that gave impetus to this study, as well as the research questions and aims that the current study sought to address. In relation to the problem under investigation, this chapter focuses on the theoretical framework and literature review in order to explore issues around the teaching of NS concepts to second language learners. This section discusses the theoretical framework of the study and the following educational theories: constructivist theories of learning, conceptual change theory, cognitive learning theories, and theories of second language learning, and how they are related to science language and learning.

The understanding of similarities and differences within the literature review, theoretical framework and conceptual framework helps beginner and experienced researchers in organising, conceptualising and conducting their research; whether qualitative, quantitative or mixed method. According to (Henning, Van Rensburg & Smit, 2009) the conceptual framework offers a picture of what is being studied, showing a representation of the main concepts the key factors, constructs or variables and the presumed relationship among them. According to House (2002) a conceptual framework is an essential part of the written report. Theoretical framework can be made up of a combination number of elements that belong to a more than one theoretical modem. A theoretical framework is the intellectual structure which guides the study and informs the view of the data.

The following section looks in some greater detail, at what theoretical framework is and its importance in a research study. The social constructivist's theory on which the present study is underpinned is also discussed.

2.2 THEORETICAL FRAMEWORK IN THE RESEARCH

A theoretical framework is a collection of interrelated concepts which guide the research, determining what things the researcher would investigate, and how the researcher would analyse and interpret data (Borgatti & Foster, 2003). This study is embedded within the theory of social constructivism. In this study, constructivist thinking is acknowledged, especially the claims for deep and active learning. In social constructivism, learners acquire knowledge by participation in authentic tasks situated in an environment that is permeated with distributed knowledge. Social constructivism maintains that knowledge is constructed in the mind of the student (Bodner, 2004). The central tenet of constructivism is the idea that conceptions held by each individual guide understanding.

Social constructivism has been chosen as the overarching theoretical framework for two reasons. First is the widespread acceptance of constructivism as theory of learning and teaching (Ogunniyi, 2002) and the empirical studies (Wu & Tsai, 2005 & Uzuntiryaki and Geban, 2004) which demonstrate the superiority of social constructivist orientated instruction over traditional teaching in terms of student's achievements. Social constructivism, as Tobin (2002) states, is the current paradigm in science education. Second, the constructivist perspective offers ways of making sense of commonly observed things in classrooms such as students' persistent mistakes (Tobin, 2002). Identifying sources of persistent errors has become more important than merely giving students correct answers. This study sought to identify metacognitive and epistemological factors, which students may be unconscious of, but which nevertheless, affect their learning of NS.

A theoretical framework facilitates the dialogue between the literature and research study (Henning, Van Rensburg & Smit, 2009). The research process involves continuous contemplative consideration of interrelated main concepts of the research study. Henning states that a theoretical framework leads to a specific *conceptual framework,* which can also be described as "an alignment of the key concepts of the study" (Henning et al., 2009:26). Suitable and relevant theories that inform the study should be fully explored to show a clear link between the study conducted and theory. In this study, the social constructivist theory informed the study, and the next section discusses the theory and how it informed the study.

2.2.2 THE SOCIAL CONSTRUCTIVIST THEORY OF LEARNING

Among the elements of social constructivism which informs the study, is the view that the learner, through cooperation with others in the learning environment, actively constructs knowledge. This element of the theory assists in formulating research questions by addressing the role of the teacher and the learners in the teaching and learning of Natural sciences concepts. Social constructivism also places emphasis on the role of the more knowledgeable others in the learning process, and the study closely looks at strategies used by the teacher in the teaching of science concepts. Social constructivism further shows that learners construct their knowledge based on their experiences from everyday life (Chaula, 2014). The study should consider the link between the teaching of science concepts and learners' prior knowledge and experiences. The use of language as a cognitive tool in teaching, learning and knowledge construction is another element of the social constructivist theory informing the study. Setati (2011) mentioned that communicative and cultural tool used for acquiring, developing, and sharing knowledge and culture, enables human social life to continue. In teaching concepts of science to English second language learners, the role of language is very important, and the study looks at how the issue of language affects the teaching and learning of science concepts.

The conceptual change theory is one of the modern theories of learning that has helped to expand understanding of constructivism. The learner was considered as one that comes into learning situations blank (a tabular rasa). This view shaped the traditional approach to learning, which was that all students' minds process information in the same linear pattern. Wereiams (2006) asserts that this pattern became the model or teaching template for countless decades. Instruction had the same basic steps as follows:

- teachers present the information while the students listened carefully;
- students take notes and memorize them; and
- teachers interact with the students through teacher-directed questions and answers.

Students returned this information to the teacher to prove they had learned the content of instruction. The Natural Sciences learning area aims to promote scientific literacy, which involves the development of process skills that may be used in everyday life in different settings.

2.2.3 CONCEPTUAL CHANGE AS A LEARNING THEORY

Conceptual change is the process through which people's initial understandings or beliefs are altered to more closely align with scientifically-held understandings (Vosniadou, 2008). There are competing theories on the nature of these initial understanding or beliefs. However, for purposes of this dissertation, the researcher subscribes to the framework theory because it is the most accepted theory by conceptual change practitioners. The view of conceptual change sees students as naive to ideas about science concepts as existing within a cogent framework with a distinct ontology which can give rise to predictions and explanations for phenomena that it encounters. This naive framework has usually not been acquired through hypothesis testing, and there is usually no metaconceptual awareness. Learning then is seen as a reorganisation of the knowledge within the framework, and not only its enrichment (Vosniadou, Vamvakoussi & Skopeliti, 2008). Conceptual change can happen naturally in the process of cognitive development and can also be induced instructionally. The concept change can range from the mundane to the more radical (Inagaki & Hatano, 2013; Vosniadou et al., 2008). Conceptual change is a latent variable that cannot be directly observed or measured but is presumed to exert influence on other observable variables such as learning or achievement. Hence, conceptual change has been operationalised as a transformation in learners' knowledge, beliefs and interests (Pintrich, Marx & Boyle, 1993; Plummer et al., 2010; Vosniadou, 2008). Conceptual change research has its roots in constructivism and grew out of the observation that learners have persistent alternate conceptions that are very resistant to change, even when the learners have been taught the correct conceptions in schools. Conceptual change research has focused on understanding how these alternate conceptions develop, why they are difficult to change, and how people can be induced to change them.

One of the first theoretical frameworks for conceptual change was put forth by Posner, Strike, Hewson and Gertzog (1982) where they identified two successive conditions that can induce conceptual change in learners. First, the learners must be dissatisfied with their current understanding, then the new knowledge must be intelligible (understandable), plausible (believable) and fruitful (produce correct explanations about related phenomena). This classical approach to conceptual change persisted for a long time but has been criticised for its over-emphasis on logical and rational thinking, its sole focus on the learner's cognition and not on the learner as a whole, and for consequently, ignoring the affective (motivation, values, interests) and other social components of learning (Duit & Treagust, 2013; Pintrich et al., 1993).

The study was also informed by the conceptual change theory by Posner et al. (1982), the theory argues that the main purpose of teaching science is to promote changes in learners' conceptions. According to Ozdemir and Clark (2007), in line with the conceptual change theory, the teacher should adequately assist learners deal with prior misconceptions about science, that emanate from their culture, background and language. Such misconceptions should be corrected, and new conceptions which are scientifically explained and proven, added. Posner *et al.* (1982) also state that for the new conception to be assimilated or accommodated, it must be intelligible (clear enough), plausible (reasonably true) and fruitful (potentially productive). This theory provides ways of looking at how teachers teach science concepts to English second language learners who have a different first language and different cultural background which may affect their understanding of science concepts.

In terms of conceptual development, Vygotsky (1968) makes a distinction between children's spontaneous concepts, which develop unsystematically through the interactions of everyday life, and scientific concepts, which form part of a system of concepts mediated through schooling. Setati (2011) recognises that "concept formation is a creative, rather than a mechanical passive, process; a concept emerges and takes shape in the course of a complex operation aimed at the solution of some problem, memorising words and connecting them with objects does not in itself lead to concept formation; for the process to begin, a problem must arise that cannot be solved otherwise than through the formation of new concept. Linguistics and conceptual development converge in the process of early word learning. Acquiring new words requires the learner to identify a conceptual unity, identify a linguistic unity, and establish a mapping between them. Natural sciences concepts involve grouping together entities based on some similarities. Teaching NS allows to organise experience into coherent patterns and to draw inferences from situations when teachers lack direct experience. Teachers do not only save us mental effort, but also allow us to apply previous knowledge to new situations.

2.2.3.2 The use of learners' home language to address conceptual understanding in Natural Sciences

The current study also deals with the issue of additive bilingual teaching, which is the teaching of natural sciences concepts to English second language learners in primary schools, together with English for purposes of both teaching and assessment. Studies of code-switching in the classroom also form a basis for the dual-medium approach to teaching, in which certain strategies and mechanisms to develop natural sciences concepts and terms are employed (Ezeife, 2003). However, a learner's corpus goes one step further, to some extent formalising terms that teachers might or might not accept as scientific terms in a language other than English (Van der Walt, 2008). For learners, the teaching and learning of science takes place in an academic setting, in which language is context-reduced (Mayer, 2003). After the foundation phase (making up the first three years of schooling), the English language is used as the medium of teaching and learning. Nevertheless, the learners concerned are expected to take part in the process of teaching and learning of science by way of 'talking about', describing' and 'explaining' scientific concepts (Ezeife, 2003). As a result, it is difficult for such learners to contribute their prior knowledge, reflections and life experiences to classroom discourse using English as their second language. In addition, science has its own specialised register that requires mastery (Van der Walt, 2008). Language plays an important role in the development of NS concepts. This suggests that the teacher's language is important in teaching NS and for creating the condition for meaningful learning. Language is necessary even when doing practical work. Teachers must explain what they are doing, and students need to ask questions.

2.2.4 Code-Switching

Code-Switching is switching from one language to another to create a special effect. Language contact is when two or more languages or communities speaking those languages come in connection with each other. Code Mixing is mixing of mostly words, but also phrases, clauses or even complete sentences of two languages or varieties. Coming together of individuals or communities speaking distinct languages most often results into bilingualism within the communities or its members. Language contact and bilingualism are the prime causes of code mixing and code-switching in speech communities. This contact situation is not only brought by physical interaction of the speakers. It can also be social media interaction. Some other examples that facilitate language contact are academic or non-academic reading in a non-native language. And switching is done in a setting or for a particular purpose. And code mixing is done more out of linguistic requirement.

Code-switching is considered a tool which could provide spontaneous and reactive discussion of concepts by learners and teachers in their main language (Setati, 2007). In a study conducted in Malaysia, Ahmad (2009) observes that teachers employ code-switching as a means of providing learners with the opportunities to communicate and enhance learners' understanding. Ahmad's (2009) finding seems to support the use of code-switching in the teaching of learners. The respondents who were interviewed by

Ahmad (2009) acknowledged that their teachers' code-switching assisted them in feeling less during the lesson. Code-switching serves to enhance communication and a logical pattern of language mixing emerges. When learning a new language, learners code switch in the native language as they acquire new vocabulary in the second language. Learners find that the new vocabulary items add breadth to their language.

Vuzo (2007) further found that learners scored better on achievement when they had been taught in Kiswahili than when they had been taught in English only. Her findings show that learners learn better when they can use a familiar language as the language for acquiring new knowledge. Her findings seem to suggest that where learners are taught in their mother tongue, they cope better with content than when teaching and learning is conducted in a language which is not their mother tongue. This means that code-switching has a bearing on the academic performance of learners in a multilingual class. It implies that in multilingual classrooms, teachers should implement code-switching in their teaching and learning in order to meet the objective of the Department of Education which are related to socio-political, ethical awareness, sensitivity to cultural beliefs, prejudices and practices in society as it is of South Africa's priorities according to President Zuma' s speech while visited Eastern Cape schools on June 07, 2011.

Code-switching has always occurred in classrooms, with teachers and learners moving between the official medium of learning (that is. English/isiXhosa) and another language they are both familiar with. According to Murray (2002) code-switching is a positive and productive approach. From Murray's (2002) findings, code-switching is one of the strategies that could be employed by teachers in supporting non-isiXhosa speaking learners in the teaching and learning of NS concepts. Furthermore, code- switching performs various functions in its naturally occurring context in such a way that speakers code switch to manipulate or influence or define a situation as they wish, and to convey nuances of meaning and personal intention (Sert, 2005).

2.2.4.2 Code-switching as a teaching strategy

The additive strategy of multilingualism is linked to the concept of code-switching, which is the norm in classroom practice in South Africa. Van der Walt and Mabule (2008) observe that the use of code-switching in the classroom situation is not well documented, though anecdotal evidence suggests that such use is common practice. The teaching of Natural sciences concepts in most township and rural schools is dominated by a high degree of code-switching and code-mixing. Heugh (2003) mentions that Intermediate and Senior Phase teachers in Western Cape townships conduct most of their lessons through the medium of Xhosa, with some code-mixing (using a few English terms within a predominantly Xhosa discourse). A clear distinction has to be drawn between codeswitching and code-mixing. It also means that code-switching has a bearing on the academic performance of learners in a multilingual class.

This means that code-switching is vital to assisting learning and teaching in linguistically assorted classrooms. The primary aim of any educational readiness is to prepare students for life including the present. To achieve this aim, the creativity has to incorporate certain teaching approaches and strategies in the classroom. One of such approaches that can improve teaching and learning is code-switching, which is a method for experimenting with multiple languages. Setati (2009) repeats the statement of 2004 that the Language in Education Policy in South African schools recognises eleven official languages and is supportive of code-switching as a resource for learning and teaching. This means that code-switching for English second language learners, especially those who are doing science, is very important.

2.2.4.3 Functions of code-switching

Code-switching has a variety of functions which vary according to the topic, the people involved in conversation, and the context where the conversation is taking place. According to Baker (2006) code-switching can be used to emphasise a particular point. In a Physical Sciences lesson, a teacher is expected to switch from the LoLT (English in this case) to the home language of the learner (isiXhosa) when he/she wants to emphasise a point. The teacher has to switch to isiXhosa because it is the language that the learners understand better than they understand English. The teacher can substitute a word in place of an unknown word in the target language. For example, if an English word is encountered that learners do not know the meaning of, even when an explanation is provided, the teacher can substitute an isiXhosa word for the English word, where possible. Code-switching can also be used to express a concept that has no equivalent in the culture of the other language, or to reinforce a request already made in English, so that the learner is able to participate fully in the lesson clarify a point. Complex points are understood best if they are expressed in a language that one understands better. Other important uses are to establish identity, build friendship, ease tension, and inject humour into a conversation. In some bilingual situations, code-switching occurs when certain famously complex or difficult topics (such Quantum Physics, Electrochemical reactions, or Einstein's Relativity Theory) are introduced.

2.2.4.4 Disadvantages of code-switching

Olugbara (2008) states that teachers have a negative attitude towards code-switching and feel that it promotes reliance on the bilingual learner's first language rather than the target language, which is the LOLT and also the language of assessment. English is the only language used in the examinations for most English Second Language learners. There is no code-switching during examinations, and this makes it difficult for the learners to communicate their answers in the target language, which is English (Van der Walt & Mabule, 2008). As a result, most teachers tend to stick to English when teaching, even though it might be clear that their learners do not understand. They feel learners have to get used to the language of assessment. Teachers are faced with the challenge of teaching learners of limited proficiency in English and they cannot benefit much from code-switching (Moodley, 2007). Science examinations are set and written in English. While learners of limited proficiency in English may understand the concepts through the use of code-switching, these learners would fail to articulate their ideas in English during examinations, thus; would not benefit much from code-switching.

2.2.4.5 Problems encountered after language switching or language change

Language switching is the language substitution of one language by another usually takes place when learners are taught in one language for example Afrikaans, and then completely change the language taught in another language, like English language. A study conducted by Aziz (2003) in Malaysia reported that learners encountered language as well as content problems in schools during implementation of English language in learning science and mathematics. In learning science, learners frequently encounter more problems in understanding science concepts, principles and science relationship with other subjects. Studies to asses engineering learners' perceptions in learning science at a University of Technology in Malaysia and some schools in Johor were carried out (Aziz, 2003). The reason why science subjects were difficult to learn is that the concepts were abstract and difficult to understand, and the learners had alternative meanings of certain science words before any teaching took place. Science concepts knowledge and skills can only be delivered through language therefore learners understanding in science is affected by using English as medium of instruction. Language plays an important role in communication and thinking; and is a tool for exchanging ideas and concepts between individuals (Aziz, 2003). To overcome the learning problems, Aziz (2003) suggests that learners 'need guidance from teachers and emphasis should be put on building up learners 'proficiency in English before they can learn Science effectively. Aziz's (2003) study established the following: the learners considered English as an important subject to learn and it was useful for everyday communication, as well as a tool for learning science. The learners felt that learning science in English was difficult. A significant correlation existed between English results and other subjects' monthly test results such as English and Science. Science has been found to be more affected by the implementation of teaching science in English. Malay language has been previously used as a medium of instruction for learning science in schools (Aziz, 2003).

2.2.5 Principles of Social Constructivist Theory

Different scholars have given different principles of social constructivism. The researcher has chosen to present Vygotsky's (1962) principles related to teaching and learning. Learning and development is a social, cognitive activity, and the zone of proximal development can serve as a guide to curricular development. Learning extends beyond school, at home and in other environments. Classroom activities should always be related to real life (Irby, Brown, Alecio, & Jackson, 2013). Dzama (2003) gives an epistemological assumption upon which constructivist learning is centred. They believe that classroom activities should always be related to real life (Irby, et al., 2013). Knowledge is physically constructed by learners, who are involved in active learning; is symbolically constructed by learners who are making their own meaning to others; and is critically constructed by learners who try to explain things they do not completely understand. In addition to this, Bruner (1966) describes three key principles of constructivism. The first principle is readiness related to the instructions. The second principle is spiral organisation which means the content should both be structured and sequenced effectively. The third principle is generation, and it pertains to instruction going beyond the information given.

2.2.5.2 Implications of social constructivism to teaching and learning process

Content implications

Vygotsky (1962) believes that the lesson designed for a group of learners should be learner-centred and oriented towards activities through which they can be able to construct their knowledge as a result of recognition of one's experience. He considers the fact that any function in a child's cultural development appears on two planes:

"*It appears first between people as an inter-mental category, and then within the child as an intra-mental category. This is equally true of voluntary attention, logical memory, the formation of concepts and development of were"* (Cobern, 1996).

From the explanation above, it means that teaching of NS concepts to the pupils with learning difficulties learn new knowledge from other learners who attend the same class at schools using home language. And those learners later can construct their own knowledge. This was a result of interaction between the children in the classroom and outside the classroom. Constructivism has been used and applied in the field of teacher educational leadership. Creswell (2003) points out that one of the key components of constructivism is learning through reflection. That means reflection cannot occur unless the learner has used thinking to make a change that could be seen in action. Basing on constructivist theory, the learner theorises based on current experience, imagines another course of action, and takes action. Without the follow-up action, reflection has not occurred as Irby et al. (2013) says. In addition to that, Vygotsky, (1962) argues that where there is no self-movement, there is no place for development in the true sense of the word. In Piaget's theory, it is believed that one phenomenon replaces the other, but it does not emerge from the other (Rieber, 1987).

Social constructivists insist that teachers should conduct assessments to find out if their set goals have been achieved. Assessment for learning may be referred to as the way of monitoring students' achievements while the process of learning is going on. This can be used by the teachers in the classroom to improve their teaching strategies. In assessment for learning, the teacher is able to identify students' area of weakness and work on it. Assessment for learning, according to Chartered Institute of Educational Assessors (2008), is a powerful way of enhancing pupils' success. It is built on the principle that pupils improve most if they recognize the purpose of their learning, whether they understand the goal and how they can attain it. Therefore, assessment for learning is considered central to effective teaching and learning. In social constructivism, educators believe that science concepts should be measured in terms of what teachers teach and what students learn. To make learners involved in the lesson, the teacher needs positive qualities of good assessment (Irby, et al., 2013). Assessment requires students to be effective performers with acquired knowledge, presents the students with a full array of tasks that align with the priorities and challenges found in the best instructional activities. It also attends to whether a student can craft polished thorough and justifiable answers, performances, or products. Furthermore, it attends whether they can achieve validity and reliability by emphasising and standardising the appropriate criteria for scoring such varied products.

Assessment can be used as a tool to know if the students understood what they were supposed to learn. As a teacher, assessment is necessary because it might lead to successful achievement of educational goals. Teachers should assess themselves to know the extent to which they have achieved the goal of equal and quality education. Assessment helps teachers to know where they went wrong in the whole process of teaching and learning of Natural Science; and failure in implementation should be seen as another opportunity to improve the way of teaching.

2.2.5.3 Pedagogical implications on NS teaching and learning

Constructivist theory advocates a change in the role of a teacher from being a director to being a facilitator. In the classroom situation, the role of teacher changes from that of transmitting knowledge to students to being facilitator when teaching from a constructivist theory of learning framework. That means it emphasises the good cooperation between the teacher and students and among students themselves. Here, the students' feeling of identity is improved and they develop high self-esteem as they are involved in the whole process of teaching and learning. The constructivist teacher mediates, coaches, stimulates and supports students' progress, and assesses their understanding (Cobern, 1996). Students who use basic forms of tools and methods of experts in the subject area to actively construct their knowledge have greater generalisation skills and transfer of learning to new contexts.

In addition to that, Pelech and Pieper (2010) argue that a constructivist teacher views his or her role as one of managing the learning environment and acting as guide, facilitator,

and coach. They observe that the role of the constructivist teacher is not one of transmitting knowledge. Furthermore, it is believed that students who work in cooperation with others have a greater chance of developing their knowledge and skills. Irby et al. (2013) argue that students who cooperate in small groups develop superior critical thinking skills and have longer retention than those who work alone. In addition to that, involving students and requiring their participation has shown positive results in diverse learners. Learners with different problems in learning may be helped by their peers to understand well. This shows that cooperation is an essential component of constructivist theory.
Westwood (2004) argues that knowledge is socially constructed and therefore, requires interpersonal collaborative effort among learners.

Sterret (2011) agrees that there is a strong relationship between school leaders and students' achievement. School as an organisation which consists of teachers and other stakeholders working together, can achieve the goal of implementing comprehensive education in primary schools. This can be related to education management as a system which consists of different parts which are related and interdependent to other systems. Generally, system theory sees human behaviour as the outcome of shared interactions of persons who are within the same social systems. It has been realised that establishing routine and consistently following them built important relational trust among the leader and teachers (Sterrett, 2011).

The major issue in system theory is communication. Communication may be defined as the process of sending and receiving information from one person to another, this can be done either verbally or non-verbally. Lunenburg (2010) identifies important elements of the communication process which are: Sender, medium, message, noise, receiver and feedback. Sender is a person who initiates the message. Receiver is an individual to whom a message is directed. Message is the spoken and or written content that needs to be encoded by the sender and interpreted by the receiver. Medium is the channel by which the message is delivered and received. Feedback is the response from the receiver indicating whether a message has been received in its intended form. In line with this, Sterrett (2011) suggests that a successful school needs to have a successful educational leader who will support and monitor all the issues taking place at school.

2.3 LITERATURE REVIEW

This part of literature relating to the current study was reviewed and discussed. The discussion of the literature is divided into subsections which relate to the various aspects of the current study. Different studies have investigated factors related to the motivation for science learning (Aziz, 2003). Then scaffolding on teaching and learning of NS concepts is discussed. Objectives of this study link with the research questions that are discussed perspective for teaching of natural sciences concepts to disadvantaged learners.

Researchers have identified a link between science achievement, the motivation to learn science, and gender and race (Leaper, Farkas & Brown, 2012). Family influences have been singled out as a key influence on the motivation for science learning and science achievement (National Science Teachers Association, 2009). Motivation to learn can be defined as "the degree to which students invest attention and effort in various pursuits, which may or may not be the ones desired by their teachers" and a division is made between achievement and performance motivation goals (Brophy, 2010). In science learning, learners motivated by achievement goals engage in science learning for the satisfaction that they attain by acquiring new knowledge and skills (Vedder-Weiss & Fortus, 2012). In contrast, learners who are motivated by performance goals compare themselves to others and compete to be better than their peers in science learning (Vedder-Weiss & Fortus, 2012).

In South Africa, several factors have been identified as having an influence on science motivation and science achievement. These include: inadequate school resources, and weak household infrastructure (Maree, Aldous, Hattingh, Swanepoel & Van der Linde, 2006); poor teacher preparedness to teach science and weak science pedagogy (Seroto, 2012); limited English proficiency of learners (Howie,et al., 2008); poor quality of learning environments that demotivate students to learn science (Ramnarain, 2013), and negative learner attitudes to science, insight into the value of science and poor self-efficacy for learning science (Juan, Reddy & Hannan, 2014). However, South African studies that have focused exclusively on the influence of family experiences on motivation for science learning and achievement are limited. An analysis of South African science performance in TIMSS 2011 gave some attention to family variables as an explanation for

TIMSS results. A strong positive relationship was indicated between participants' science achievement and parental education. Only 19% of South African participants in TIMSS 2011 had at least one parent/caregiver who had completed a university degree or higher qualification (Reddy et al., 2012). Mashile (2001) observes the difficulty of using SES, parent involvement and parental attitudes to determine science achievement in the South African context. Makgato and Mji (2006) undertook a qualitative study of science performance in township schools in Gauteng (the negative influence of poor parent involvement on the science achievement of learners from dis-advantaged families). They found that learners and teachers believed that parents' low educational levels and lack of scientific literacy precluded them from any meaningful involvement in their children's science learning that could be motivational.

The main challenge in a multilingual classroom is for the teacher to understand the language problems that learners have, and to develop pedagogical practices to overcome these problems. Language has an impact on the understanding of key science concepts. Adams (2003) elaborates that science is language made up of words, numeracy and symbols that may be connected. In multilingual classrooms, the biggest challenge is for educators to understand the difficulties that learners face in understanding and making sense of science language (Boulet, 2007). Setati (2008) argues that Language of Learning and Teaching (LoLT) is a complex political issue in South Africa. Most learners and teachers prefer using English as a Language of Learning and Teaching (LoLT) despite research suggesting that the learners' home language should be used (Setati, 2008). The use of English to promote understanding by both the learners and teachers is politically motivated (Setati, 2008). English is seen as an international language used to access social goods, and most textbooks are written in English, and higher education uses English as well (Setati, 2008). The power of language cannot be under-estimated in the selection and use of examples.

The literature reviewed in this section views the teacher as key in the use of appropriate language of instruction for learners to understand Natural sciences concepts. According to Oyoo (2009) this is the teacher's science classroom language. This becomes the most important resource in the learning process and needs to communicate with the learners using understandable language. This means that the language used by the science teacher should be understandable to all the learners. It was mentioned that the teachers'

PCK involves the teacher's need to understand that teaching is not about delivery of content knowledge only, but that it is concerned with acquiring improved skills of helping the learners. One of these skills is to use the language of teaching and learning in a correct way in order to assist the learners.

Some reflections on the South African teacher education context suggest that teachers find it difficult to implement open-ended inquiry in science classrooms. According to Kriek and Grayson (2009), the state of science education in South Africa is a cause for concern. This situation can be attributed, in part, to many science teachers' limited content knowledge, ineffective teaching approaches, and unprofessional attitudes. However, content knowledge alone is not enough, as indicated by Adler, Reed, Lelliott & Setati, (2002), who write, "The issue is how to integrate further learning of the subject with learning about how students in school acquire subject knowledge". They suggest that teachers need to learn "subject knowledge for teaching". This kind of knowledge is acquired during teacher training; and to the South African science teachers, this is obtained during preservice or in-service programmes at universities since they are the only institutions of teacher training.

2.3.2 Scaffolding in Teaching and Learning of NS Concepts

Scaffolds are support mechanisms that help a child to carry out a task which he/she would not be able to do on their own and which supports them until they are able to complete the task independently (Brush & Saye, 2002). The concept of scaffolding, introduced by Bruner, has been used within the context of Vygotsky's sociocultural theories in trying to describe the role-played by teachers or more capable peers in helping learners to move through their Zone of Proximal Development (ZPD) (Collins, Brown, & Holum, 1991; Murphy, 2012; Verenikina, 2008). Brush and Saye, (2002) suggest that two types of scaffolding are needed to assist teachers and learners when using learner-centred approaches. Soft scaffolding refers to verbal interactions that occur when teachers identify difficulties in understanding and provide some sort of support that guides the learners (Murphy, 2012; Rosenshine & Meister, 1992; Verenikina, 2008). Hard scaffolds refer to any sort of teaching aid or material prepared in advance that can be used to assist learners' understanding (Brush & Saye, 2002). Brodie and her colleagues (2002) point out that in

South Africa, the space between what the learner knows and what they need to know, that is. their ZPD, in many schools is huge. This is a problem because it makes scaffolding very difficult. This is a dilemma, because if the teacher reduces the space to a manageable size, learning is more effective, but the pace is much slower and coverage far less. In language of teaching and learning, teachers also need to be aware of the language difficulties learners may experience with regard to learning about in English, and may support language practices such as code-switching or learning in their home language that assist learners to communicate more freely with their teacher and with one another while moving through their ZPD and learning new concepts. Rogan and Grayson (2003) believe that learners' proficiency in the language of instruction can influence the capacity of a school to support an innovation. This is because learners for whom English is an additional language and who are not proficient in English, are less able to understand new materials and participate in activity-based and learner-centred activities, if the teacher insists on them using only the language of instruction. A further area of sensitivity needs to be learners' home backgrounds. Teachers would need to be aware of the conditions in which the children live, the resources they have access to, the presence or absence of parents or some guardian, and in some cases, the availability of necessities such as food, clothing and shelter. The socio-economic conditions for children range from extreme poverty to extreme wealth, and the conditions of those living in poverty have a significant impact on their learning (Fleisch, 2008).

2.3.2.2 Importance of resources in teaching and learning of NS

From research, Idiaghe (2004) established that learners in schools with inadequate teaching and learning facilities performed lower compared to their counterparts in schools with adequate facilities. As Mudulia (2012) mentions, suitable resources in science teaching are essential to all scientific teaching and learning. The necessary apparatus should also be available as well as other materials required to carry out the experiments. Mudulia (2012) further notes that for effective science teaching, textbooks, revision books, lab chemicals and equipment must be provided.

There are some resources that are needed for teaching Natural sciences in South African schools listed against each theme to assist teachers with planning and preparations. The list is a guide and suitable alternative tools and materials may be used (Department of

Basic Education, 2011). The policy document mentions that every learner must have his/her own textbook whereas the learners most of the time do not understand the science concepts because of the language they are using in teaching and learning.

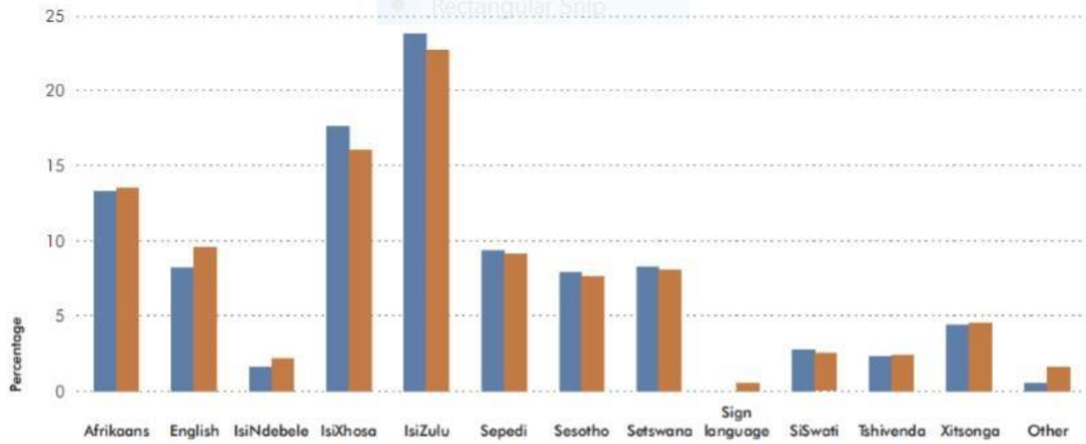
Teachers must make sure that a scheme is in a place for improving textbooks at the end of the year. Schools must also provide secure storage space for textbooks and other equipment. The Department of Basic Education (2011) states that teachers should remember that it is more important for learners to have the experience of carrying out investigations than to depend on the availability of equipment. Teaching materials should match individual learning styles, that is. visual, auditory and kinaesthetic (Leach & Scott, 2000). Jacobz, (2002) also observes that focusing learners' attention on the material to be learned is an important factor in effective learning. The importance of laboratory, apparatus and electricity in teaching and learning of science cannot be over emphasised. Tobin's (1990) states that the science laboratory is very important in ensuring the effectiveness of science teaching. Tobin notes that meaningful learning is possible in the laboratory if learners have opportunities to manipulate equipment and materials in an environment suitable for them to construct their knowledge of phenomena and related scientific concepts. Teachers must ensure that learners are familiar with rules regarding the safety of science equipment during the teaching and learning of NS. Daniels (2012) mentions that software can help teachers bring the real world to learners using sound and video, and by interacting with a picture or diagram by enlarging or rotating it. Nayar and Pushpam (2000) report that when teachers integrate appropriate media in the curriculum, their learners achieve significantly higher learning outcomes. As Nayar and Pushpam (2000) rightly observe, learning resources clarify material even to the slow learners. When the teacher uses DVDs in the classroom as a learning tool, for instance, demonstrating to learners the way of connecting an electric circuit, learners watch and practise hands on and keep the steps in their minds. This means that learners understand better and can practically demonstrate the skills even without the help of the teacher, sometimes in an understandable language that is mother tongue. This is in line with Vygotsky's social constructivist theory. Resources play a significant role in the teaching and learning of science.

2.3.3 The Language of Learning and Teaching Science

South Africa is a multilingual country that mostly uses English as the language of instruction for teaching and learning in science (Prophet & Badebe, 2006). South Africa has 11 different official languages which include English, and English is a second language for the majority of students and poses a barrier in the learning and teaching of science. The barrier is widened by the difference between scientific or technical English and common English usage (Muwanga-Zake, 2001). The language barrier could account for the difficulty that learners and teachers find in science. Prophet and Badebe (2006) observe that the understanding of words could have a direct bearing on the students' performance in science. Whereas according to the South African Census (2001), English as a home language is spoken by only 8.2% of the population, yet English has become 'the major language of communication for business, government and education' (Sherin, 2006).

Therefore, an overwhelming number of learners are being taught in a language other than their home language (Wilkinson, 2005), and often by teachers not adequately prepared to teach through the medium of English (Farrel & Ventura, 2010; and Heugh, 2009:97; Sookrajh and Joshua, 2009:334). The statistics for South African Census (2011) also show a similar trend to the statistics for Census 2001 with regard to English as the main medium of instruction in schools, although it is spoken as a home language by only 9.6% of the population.

Fig. 1: Population of South Africa by first language spoken at home – Census 2001 and 2011



	Afrikaans	English	IsiNdebele	IsiXhosa	IsiZulu	Sepedi	Sesotho	Setswana	Sign language	SiSwati	Tshivenda	Xitsonga	Other
Census 2001	13,3	8,2	1,6	17,6	23,8	9,4	7,9	8,2		2,7	2,3	4,4	0,5
Census 2011	13,5	9,6	2,1	16,0	22,7	9,1	7,6	8,0	0,5	2,5	2,4	4,5	1,6

In SA and other countries where many pupils do not learn in their home language, curriculum designers have judged the appropriateness of the language in which science is taught by considering whether it is the learners' mother tongue or not. According to Wet (2009) students learning in their mother tongue are said to have an advantage over their counterparts being taught in another language. The assumption among teachers is that all learning follows smoothly once learners have attained proficiency in the language of learning and teaching. But not everyone who is proficient in the language of teaching and learning excels in science. There is the misconception that home language education would lead to social, economic, and political disempowerment. Therefore, South African learners choose English as the preferred language of instruction (Wet, 2009). This means that the education has side lined the home languages and the majority of South African learners use English as a second language in schools. South African learners encounter more complications with the language of the science classroom. Many research studies in other countries have proved that second language learners experience more difficulties with the use of the science teachers' classroom language (Wet, 2009). The researcher intends to establish whether South African learners also encounter such difficulties in teaching and learning on NS concepts.

2.3.3.2 Learning science in English

Language is the most common medium through which learners and educators interact in the Science classroom. Given this, parents, educators and learners need to understand that whether learners are studying Literature, History or Science; they need fundamental language skills to understand information and express their ideas on it. It is through language that learners are able to acquire skills that are essential in the workplace and for their livelihood (Setati, 2007; Yushau, 2004). Communication in Science relies heavily on context reduced, cognitively demanding language, which has been identified as being particularly difficult for second language learners to acquire (Cummins, 2000). According to Oyoo (2008), “language is a system of sounds, meanings and structures with which we make sense of the world around us”. In science education circles, language is very important for the teaching and learning process. It enables teachers to be understood by learners as well as to convey explanations and instructions to them.

The importance of language in learning and teaching Science cannot be under-estimated. It is important for learners in developing their scientific knowledge, and for educators in understanding their learners’ learning processes. But research has shown that the ways in which educators and learners use language in the classroom are complex and the effects, though considerable, are often highly subtle and not self-evident. Therefore, it is important to establish what happens with language, why it happens and how it happens, since language is a tool that is used for expressing information and ideas. A variety of linguistic and non-linguistic modes are used for communication: listening and talking; reading and writing; discussing and arguing; narrating and describing; using actions, images and symbols–all of which are ways of signaling meaning and what linguistics term ‘semiotics’ (Setati, 2011).

Setati (2009) asserts that teaching and learning are largely facilitated through the use of second language. Not only is language used by educators to communicate information to learners, but also language is necessary for the complete formulation of most concepts and principles. In Science classrooms, one of the primary ways for learners to demonstrate knowledge and understanding of scientific ideas is through the use of language to express their conceptions of the ideas. In the South African context, many learners come from rural homes, squatter camps and townships (Setati, 2011). Their surroundings and indigenous languages give them the picture of the world they carry into the science lesson. Some concepts are not well distinguished due to the lack of a scientific register in some indigenous languages, like the names of different types of gases. The alternative conceptions and culture that these second language learners encounter in the physics or science (classroom) may complicate the process of communication and understanding of science concepts (Setati, 2007).

2.3.3.3 Teaching of NS concepts to second language learners

There are several factors that influence the learning of and/or in a new language. Some of those factors are presented below. They should be taken into consideration in the classroom, so that an optimal learning situation can be provided. They are not only applicable to second language learning, but also to the learning of any subject, including Science. It is important for learners to get to know different ways of learning, so learners can benefit as much as possible from Science instruction (Brown, 2000). The styles affect the way learners learn and it is very important for a teacher to be attentive to the diversity of the learners. In the second language classroom, it is important to make space and time for the learners' varying strategies in order to optimise the learning process. According to Brown (2000), an optimal and successful learning situation is due to the teacher's attention both to "linguistic performance" and "emotional well-being". It is also important to have a high self-esteem so that *inhibition* does not hinder the trying of new hypotheses and making mistakes for example in pronunciation or grammatical structure, because *risktaking* is another factor that a language learner cannot do without (Brown, 2000).

Taylor (2007) asserts that "the lack of proficiency in the language of learning and teaching is a major obstacle to efforts to access the curriculum and to reduce educational inequality. Quality improvement initiatives that do not recognize obstacle are unlikely to have significant impact". Yin (2003) points out that learners for whom English is not a first language often feel overwhelmed by the complexity of the texts which they have to deal with in Science subjects. According to Leach and Tsai (2003), the root of the problem is that English classes at schools seldom equip learners with the unique learning strategies that the Sciences demand. The study's main thrust is to look at teaching of NS concepts to second language speakers, among grade 7 learners. Lesaba (2014) observes that disadvantaged learners display adverse characteristics such as *lack of work ethic, inability to manage time, failure in taking responsibility for own action, inability to work persistently* *on a problem, underdeveloped critical thinking skills, lack of reading culture and a generally low of literacy*.

In the Western Cape, Ogunniyi (2002) conducted a study among Grade 7-9 learners and observed that there was often a mismatch between the cognitive demands of a science curriculum and the cognitive readiness of those studying Science. He found that learners experienced difficulties in understanding Science texts in both linguistic and conceptual modes, and therefore, advocated simplifying the material, especially since the "language of the texts and instruction very often is well above that of learners". He also found that children could not understand concepts without their explanation in the mother tongue. Even in English lessons, reading to learners was interspersed with brief explanation in the mother tongue. This study was, however, conducted in township schools. Students have poor "study habits" and prefer rote learning rather than problem solving (Ogunniyi, 2009). Students' partiality for habit learning crash from their extensive survey of education and may live the school early. School leavers deliberate problem solving to the main point of science learning. Plummer, Zahm and Rice (2010) see the problem of learning science in Africa as one of dissonance between concepts of learning embedded in current science curricula and the concept of learning traditionally held by students and their parents.

Several studies have in recent years suggested that students' epistemological beliefs about science and science learning are significantly related to their orientations to science learning and integration of scientific knowledge (Louca, Elby, Hammer & Kagey, 2005).
Once learners use academic language in the classroom, they are "not only learning content but also learning how to participate in science-related communities" (Tan and Tan, 2008). As science concepts become more complex in middle school and high school, the language also includes unfamiliar symbols and notational systems (Tan and Tan, 2008). In a classroom observational study for the National Science Foundation, students were three to four times as likely to be attentive to "humanised" science talk as they would be to "normal" science talk in the classroom (Lemke, 2001). Students made connections between their classroom experiments and their subjective experiences, broadening their depth of understanding of mold growth. The teacher would then be in a position to easily explain the meanings of words that assume new meanings in the science context, using the learners' native language. This is consistent with the Sapir-Whorf hypothesis about

language where it is assumed that one's thoughts and behaviour are determined or influenced by their language and culture (Oyoo, 2009).

2.3.4 LINKING THE TEACHING OF SCIENCE CONCEPTS TO LEARNERS' PRIOR KNOWLEDGE PRIOR KNOWLEDGE AND EXPERIENCES

According to Dzama (2003), the importance of prior knowledge in learning science has been widely acknowledged since 1968 when Ausubel indicated that the most important step in teaching was to ascertain what the students knew about the subject and to teach them accordingly (Dzama,2003). The conceptual change approach to teaching science, gives explicit recognition to the importance of prior knowledge in science education (Duit & Treagust, 2013; Linder, 1993; Strike & Posner, 1982; Posner, Strike, Hewson & Hertzog, 1982). The importance of prior experiences has been investigated by Lundin and Lindahl (2005) that depends on the culture in which a particular child's growth. Finley (1985) cited by Dzama (2003) argues that, if prior knowledge were as important as the science education literature portrays it to be, then variation in prior knowledge would have important consequences for science learning. His/her study of variations in prior knowledge set out to determine:

- propositions that all students share with respect to a given topic,
- different groups of students whose members share distinctive sets of propositions, and
- the extent to which students' knowledge of a subject was idiosyncratic (Dzama, 2003)

Marzano (2009) describes prior knowledge as what a learner already knows about the content and observes that such knowledge is important and relevant in acquiring new knowledge. As far back as 1968, Ausubel noted that, "The most important single factor influencing learning is what the learner already knows" (Ausubel, 1968). In planning and delivery of science lessons, teachers should always recognise the need to start instruction "where the student is." This marks the difference between rote learning and meaningful learning. Rohandi (2017) argues that eliciting students' prior knowledge in the class places learners in a more responsible position for their learning. The same view is shared by Moore, Evnitskaya and Ramos (2017) who state that, by building on what learners already know, science concepts taught and learnt in class are made clearer and more real. English second language science learners may be able to express their prior knowledge in their own mother tongue, without the use of scientific language. Therefore, it is important to have learners' prior knowledge considered.

The State of Queensland's Department of Education (2002) talks of "high connection" learning which gives learners the opportunity to link their prior knowledge to the topics, skills, and competencies addressed in the classroom. The science teacher should always try to link new concepts to what learners already know. In introducing a science lesson on living and non-living organisms, the teacher may start by finding out from learners what they know about living and non-living organisms. Such an approach also helps to correct any misconceptions. In "low connection", learning new concepts was introduced without any link to learners' background knowledge. Science teachers should teach by building on learners' background knowledge. This is more important in the teaching of learners whose mother language is not English, and whose understanding of new science concepts is based on connections they make with their own prior knowledge.

Lemke (2001) explores how language is used in primary schools to communicate and construct meanings in science. He highlights the fact that learning science, which includes life and living, involves learning how to talk science meaningfully. He/she suggests that to talk science means learning to use specialised conceptual language for reasoning, and learning science also means developing the capacity to communicate in the language of science and act as a member of the community of the people who do so. These issues, in the Namibian context, seem to be learners' main challenges, but equally, they are teachers' challenges. This is because, if a teacher becomes well experienced in handling the challenges, learners may not have difficulties any more. Because the concept definitions are written in English, it takes serious cognitive processes and relentless support to unpack them and make meaning out of them. For learners to develop appropriate concept meaning, appropriate mediation methods and skills are further required. In agreement with Kocakulah, Ustunluoglu, and Ocakulah (2005), science is, and should be, regarded as a discipline in which experiential and concrete examples should be presented as part of in-class processes in order to improve students' conceptual understanding and levels of attainment.

Since the main mediation method for enhancing learners' conceptual development is English, a second language in this context, there is need for learners to be conversant with it and/or to be supported using other forms of mediating the content (Novak, 2010). Philips and Norris (2009) confirm that reading and writing are essential to science, whilst Tenopir and King (2004) underscores the importance of reading to science. According to Tenopir and King (2004), the scientists surveyed read a great deal; on average 553 hours per year of their total work time. One of the teaching strategies often mentioned is providing learners with the opportunity to do what scientists do. This strategy aims to engage students in the same thinking processes and activities as practicing scientists in which they might develop scientific concepts and ideas from their own experience (Swanepoel, 2010).

Webb (2009) maintain that scientific literacy can be promoted by encouraging students to engage in authentic science experiences such as the use of open-ended investigations which encourage learners to extract meaning from their own findings. However, in most cases, the essence of inquiry has been lost in school science and replaced with a more time efficient pseudo-inquiry which only requires learners to follow a set of instructions set out in a textbook or worksheet. Such investigations are short, generally verify what has already been studied, and the purpose is often not understood by students (Barrow, 2010; Powell & Aram, 2007). Furthermore, local and international examinations focus on the simple recall and application of scientific knowledge, and the true nature of open-ended investigations, which represent genuine scientific inquiry, are rare if present at all (Fensham, 2008). The research has to be put into the context of the educational environment of the schools the black learners attend. Ralenala (2003) conducted a study at the University of the North (now University of Limpopo) in which he investigated the reading behaviour of first-year Science students. Ralenala (2003) sought to identify and explore the study reading behaviour of first-year university Physical science learners; that is, establish the extent to which metacognitive strategies are used in the Physics reading process and the idiosyncratic use of these strategies in multilingual classrooms. The biggest challenge is for educators to understand the difficulties that learners face in understanding and making sense of science language (Boulet, 2007).

In a study by Prophet and Dow (2003) in Botswana, a set of Science concepts was taught to an experimental group in Setswana and to a control group in English. The researchers tested understanding of these concepts and found that Grade 8 learners taught in

Setswana had developed a significantly better understanding of the concepts than Grade 8 learners taught in English. A similar study with the same results has been carried out in Tanzania. Secondary school learners taught Science concepts in Kiswahili did far better than those who had been taught in English (Mwinsheikhe, 2002). In Ghana, Wilmot (2003:12) conducted a case study among second graders which showed some effects of the English language policy of Ghana. He/she made clinical interviews with 30 selected learners by probing each child's problem solving behaviour in Science, by using various tasks. Setati (2008) argues that Language of Learning and Teaching (LoLT) is a complex political issue in South Africa. Most learners and teachers prefer using English as a Language of Learning and Teaching (LoLT) despite research suggesting that the learners' 'home language should be used (Setati, 2008). The use of English to promote understanding by both the learners and teachers is politically motivated (Setati, 2008). The power of language cannot be under-estimated in the selection and use of examples.
Wilmot (2003) shows that "children who were classified as low achieving children actually had a lot of knowledge which by the school was incorrectly assessed because the children did not master the foreign language which was the language of instruction."

2.3.4.2 Teacher's connection in teaching NS concepts

Learners need to learn and develop skills which are not only helpful to them in classroom situations but also in their daily lives. *When teachers teach learners to use these skills in Science, they are also teaching them skills that they were use in the future in every area of their lives"* (Shaheen, 2010)). Preczewski, Mittler and Tillotson (2009) encourage educators to constantly link the learners' everyday experiences with their classroom lessons and to embrace a less formal process when approaching scientific investigation. Shaheen (2010) maintains that the scientific process provides an opportunity to develop and encourage critical and creative thought in learners through interacting with the natural phenomenon and the world around them, and believes that school education should be focused on developing "freely creative and original thinkers" by providing opportunities for learners to become innovative and enterprising (Hume & Coll, 2010). Science process and concepts are highlighted as important in the teaching and learning of Natural Sciences (DoE, 2007). They are the stepping stones to acquiring more complicated integrated skills. An authentic method hinges on instruction created on authentic investigations, empirical techniques, open-ended problem solving and a reliance on evidence in constructing new knowledge. Such methods aim at capturing the process of discovery within the classroom and provides learners with a sense of how science produces new knowledge (Cobern et al., 2010; Hume & Coll, 2010). Marks and Eilks (2009) also emphasise the importance of the communication skills that are gained through methods, and which can be applied beyond science and are essential for the learner to actively engage in the interactions between science and society.

2.3.5 STUDENTS' PERCEPTIVE KNOWLEDGE AND MISCONCEPTIONS

Sherin (2006) defines knowledge that is gained prior to formal instruction as perceptive beliefs or commonsense knowledge. It is called perceptive beliefs or prior-knowledge because it is based on earlier beliefs and assumptions which are sometimes inaccurate or erroneous (Kolari & Savender-Ranne, 2004). It was found that perceptive beliefs about motion are contradictory to the theory of mechanics and are also stable in such a way that traditional science instruction does little to change them (Sherin, 2006). Prior- knowledge which is not compatible with the accepted view of science has different names like errors, alternative conceptions or commonsense knowledge. What students believe about the concept at that moment is regarded as the only focus where changes desired by the teachers may begin (Sherin, 2006). To link what students should learn with their subjective experiences can be a challenging task (Liljedahl, 2002) that needs professional strategies in line with the constructivist approach. The constructivist approach takes into consideration the role of students' pre-knowledge in their construction of new understanding. In addition to the use of professional strategies derived from the constructivist theory of teaching and learning, Kolari and Avender-Ranne (2004) advise that students' ideas in their current form must be taken seriously and must be treated equally with the ideas of teachers, researchers and all other scientific communities to facilitate the process of learning.

A diagnosis of a learner's perceptive or pre-knowledge is important for teachers in order to plan consequent teaching activities and help students to link new material to what they already know (Cimer, 2007). A teacher's awareness and ability to cope with learners' misconceptions and preconceptions are of crucial significance in linking what is known by learners to what is known by the teacher. Teachers need to introduce scientific concepts using conceptual change strategies to help them construct new knowledge. Cimer (2007) identified four conditions necessary for conceptual change, namely, the conception must be intelligible, plausible, fruitful and must cause dissatisfaction to the learner about their current conception to enable change. The concept substitution strategy is used in situations where students appear to have a correct intuition associated with inappropriate physics term. If the new concept conflicts with existing concepts, then it cannot become plausible or fruitful until the learner becomes *dissatisfied* with the old concepts. Thus, learning requires that existing conceptions be restructured or even exchanged for the new concept. Such claim is supported by one of the findings in Prediger's (2006) study that learning often demands the reconstruction of prior knowledge when confronted with new experiences and challenges.

Many science concepts such as mechanics (e.g. work & energy) have been found by teachers and researchers to be particularly difficult for students and may well be among the sources of the alternative conceptions they hold (Bligh, 2000). Hesse and Anderson (1992) attribute the difficulty that students encounter in learning science concepts and their misconceptions to the students' learning methods, as well as to the teachers' teaching methods. They found that traditional teaching methods are ineffective in helping students learn the concepts. To overcome students' difficulty in the area, several instructional methods have been used. According to Novak (2010), concept may help teachers to move their own learning approaches towards more meaningful practices. Thus, they emphasise the meaning of key concepts and principles in ways students can form a conceptual understanding of the subject. Concept mapping enables the students and the teachers to visualise concepts and arrange them in a systematic way. It presents a clear picture of what students are thinking. Many studies (e.g. Ogunniyi, 2009; Rollnick, 2000) have examined the effect of language on the learning of science. The language of instruction is definitely a barrier in the learning of science for those who have English as their second or third language and receive science instruction in English. The participants in this study were English second language speakers who receive Science instruction in English. It is apposite to state that there are many related concepts in science which are given different names in English. However, in some of the African languages spoken in South Africa, the same word is used for different concepts (Moji & Grayson, 2001).

Grayson (2001) investigated the effect of a single term in mother tongue, for several related but different physics terms in English, on African students' learning of physics. They suggest that this limited nomenclature of physics concepts leads to misconceptions and poor conceptual translation which could explain the generally poor performance of African students in physics. According to Junkins (2007), students in science classes must learn how to recognize when mathematics procedures are applicable so that they can select from their "mathematics toolboxes" the correct methods needed to solve new problems. Thus, a lack of mathematical skills can have a negative impact on students' abilities to solve complex problems in physics and can greatly hinder a deeper understanding of many important concepts; especially those in physical science (Junkins, 2007).

2.3.5.2 Strategies employed by teachers assist learners in learning Natural sciences concepts

Setati (2011: 28) asserts that the importance of language in learning and teaching science cannot be under-estimated. Language is important for learners in developing their scientific knowledge, and for educators in understanding their learners' learning processes. However, research has shown that the ways in which educators and learners use language in the classroom are complex, and that the effects, though considerable, are often highly subtle and not self-evident. Educators' reflections were mainly based on the impact that teaching in a second language has on learning and teaching and the coping strategies that educators and learners employ to navigate the curricula. The study noted that in order to cope with the English Second Language (ESL) environment, educators had to increase time for teaching new concepts and that they (educators) always found themselves caught between teaching Science content and language. If they focus on the content and use the learners' home language to get concepts understood, they find themselves compromising their role in teaching English. If they focus on the English, they find themselves compromising the extent to which content is understood (Setati, 2011).

Educators therefore, need to consider two different kinds of 'learning talk': "exploratory talk, which is a necessary part of talking to learn and which is likely to be the most effective in the learner's main language, and "the discourse-specific talk", which is part of learners' apprenticeship into the discourse genres of subjects in the school curriculum" (Setati et al, 2002).

It is the second type of talk that always proves most problematic for the majority of learners who are not proficient in English. Setati et al. (2002) argue that proficiency in English must be acquired, not only through the formal English class, but during learning Science as well. A key finding of the study was that learners and educators never managed to move from the point of informal exploratory talk to discourse specific talk. In this way, educational inequalities are intensified as educators and learners are left stuck at some point in their educational journey. There was a development in an earlier pilot study among Sepedi speaking children in 1985. In that pilot development, it was reported that the quality of English of Standard 5 (now Grade 7) children was poor and that the learners themselves could not adequately handle content subjects through the medium of English. Five different reports, based on five different areas of the development team's concerns, were produced. Of relevance to this study are the two reports on English language skills and on the disparity between the English taught as a subject and the English in the content books such as Science and other subjects' books (Heugh, 2005). In the English language skills evaluation, the study focused on the conventional language skills of oral and listening comprehension, reading and writing in science. The study used a variety of tests, including composition and cloze tests. The subjects were drawn from black children in public schools. Results of the tests were compared with those obtained from non-racial schools.

Heugh (2005) reports that the situation was so distressing because "children from state schools consistently scored 30% and 40% while their counterparts displayed a mastery level of 80-90%". It was observed "a high level of grammatical error and the absence of cohesive ties and any notion of coherence marked the children's writing skills". The results also showed that the learners' oral and listening skills appeared to have been inadequately developed. In reading comprehension, the subjects appeared to have difficulties with the "why" questions. Their comprehension was so weak that they were not even able to answer low level inference questions, including those pertaining to agency, reason and cause and effect. Macfarlane (2000) referring to the results of the Project contends: "The pronounced weakness discovered with the children's English skills leads us to believe that the current generation of junior primary school children are not competent in terms of the demands of the medium transfer in Standard 3, at least in its present form". The strong negative effects of Socio-Economic Status (SES) in Science seem to emanate from the fact that this subject (Science) has new content for the secondary school learners. Learning science in a second language is always going to be particularly demanding for learners because they would have to master the basic terminology as well as develop conceptual understanding of the subject matter and comprehend the textbooks in English.

Further, studies done in Africa have helped to widen the researcher's understanding of the problem of English as a language of learning Science (Setati, 2011).

The foregoing review has suggested that the problem of poor performance in Science is a problem of disadvantaged or underprepared learners. Characteristics of disadvantaged learners have been delineated. However, these characteristics may be more of the symptoms of the disease, as it were, rather than its causes. Attempts have been made to improve the performance of the disadvantaged group (Bamgbose, 2005). This study sought to determine whether the use of English second language has an effect on the learning of Science among Grade 7 learners in township schools in the east London district of the Eastern Cape. The aim was to investigate how the use of English as a language of learning and teaching can influence the learning of Science at the secondary schools in the research area. The challenge is that South Africans need to change their attitudes towards certain languages, especially African languages as languages of learning and teaching. As noted by Bamgbose (2005), some African language speakers themselves have developed negative attitudes towards their languages as a result of their marginalisation in the economy and education of many African countries.

2.3.6 TERMS USED AT VARIOUS TIMES TO DESCRIBE SCIENCE SKILLS

According to Harlen and Qualter (2004) and Herman (2009), integrated science concepts can be taught to primary school learners. The researcher used a numeral concept to compare the teaching of NS in Grade 7. Basic science concepts apply specifically to foundational cognitive functioning especially in the elementary grades (Rambunda & Fraser, 2004). The concept teaching strategies is included to understand to what extent teaching strategies differ in primary and high school. Although the DoE, RNCS (2002) advocates a learner-centred approach across all phases, teacher-centred approaches are still the norm in many schools (Gaigher, Rogan & Braun, 2007). Establish challenges teachers and learners encounter in the teaching and learning of science concepts at various times to describe science skills.

Mastrilli (1997) in Friedrichsen, Abell, Pareja, Brown, Lankford and Volkmann (2009) examined experienced teachers' use of teaching strategies and found that they relied on traditional teaching methods and strategies. Traditional teaching methods are used because teachers are used to these methods due to their teaching experiences. Mastrilli (1997) in Friedrichsen, Abell, Pareja, Brown, Lankford and Volkmann (2009) note that the experienced teachers do not want to use new teaching strategies. In addition, he mentions that different methods of teaching can be developed from learner's conceptions in the class, and from the questions they ask. This can be done by marking learners' scripts and learning from their different answers, from learner's answers from projects and assignments, and also from observing the behaviour of learners (Lankford & Volkmann, 2009). Learners also receive and have to deal with a vast amount of information in the class due to teachers' traditional teaching strategies. This might result in a lack of enthusiasm, boredom, irritation and memorisation among learners, which do not contribute to understanding (Tekkaya & Yenilmez, 2006). Learners are prone to rote learn and memorise facts and concepts without understanding or relating to their teaching methods or learning environment using models, simulation, diagrams and concepts. Even though some schools might be short of resources, teachers can improvise to make learning more interesting. Friedrichsen et al. (2009) found science teachers hold on to their didactic teaching strategies and find it difficult to deviate from these strategies. Teachers view teaching as telling and learning as memorisation. Science teachers should make use of inquiry teaching to challenge learners and to challenge themselves to enhance their teaching methods. Enhancement of r teaching strategies is addressed by Friedrichsen et al (2009) who agree with Shulman (1986) that PCK development programs should play a major role in teacher education and training to keep the teachers challenged and motivated. Science classes have two components; theoretical sessions and laboratory or practical work sessions (Cooper, Hanmer & Cerbin 2006). Learners often enjoy the practical part more than the theoretical part because learners like to be actively involved in more hands-on activities to help them concentrate better on a specific concept taught in class. Active learning enhances learners' abilities to learn. They become motivated by interesting teaching strategies utilised in class. These in turn improve their learning and understanding and their thinking skills (Goldberg & Ingram, 2011). Active learning is reported to be helpful and a fun way to learn, because learners focus more on the topic of study and may be very intrigued by the teacher's way of teaching (Bodner, 2000).

In NS learners need to do more than active learning. They have to recall and incorporate different sections of knowledge, interpret data, evaluate, as well as explain data and phenomena. Teachers can succeed in teaching by using a variety of teaching strategies

(Bodner, 2000). An example of teaching strategy that can be used in the classroom when teaching the morphology NS concepts of the plant is by having human sized drawing of plant made out of cardboard of polystyrene, brightly coloured with labels where learners can paste labels on a cardboard in class. The labels can be roots, stems and leaves. This exercise can help learners remember the tree in class when they study for the test. This makes it more accessible and easier to study, and the learners begin to see plants as living organisms (Staub, Pauw & Pauw, 2006). The activities can be done actively when the learners understand the question properly. The reasons why the researcher investigated the teaching of NS concepts to English second language learners.

Example of teaching strategy that is useful in teaching the part of photosynthesis in NS concepts is to take the learners out of the classroom to the school grounds. The teacher could start the lesson by asking them what they see on the playgrounds. When they come to plants, the teacher could ask them; what makes plants to grow, and why plants are green. The learners are able to observe their surroundings, learn from others' answers, touch plants and sense the whole process in an enjoyable, hands-on manner (Piper & Lewis Shaw, 2010). A study has shown that by integrating technology, Most of NS concepts where there might be difficulties in teaching with real things, can be avoided (Cherubin, Gash & McClaughlin,2008). Technology can help the learner understand concepts and the learners relate to technology. Cherubin, Gash and McClaughlin (2008) designed a Digital Seed, which is considered a toy where simulations of life cycle are displayed while learners for example, water the plant through a funnel built into device to connect real life to technology. Research has shown that it fascinates learners, keeps them interested and wanting to learn more (Cherubin, Gash & McClaughlin, 2008). Although this could be a helpful method in the classroom, most schools in SA do not have the funding or available resources to use such teaching methods in class. The above researchers were trying to come up with more skills and some examples on teaching NS concepts. To teach science effectively at primary school level, science needs to be accessible, applicable and appealing to learners. Learners also want to learn by own experiences and their prior knowledge and the way in which concepts are taught.

2.3.6.2 Learner-centred strategies utilised in the teaching and learning of NS concepts

Learner-centred strategies refer to approaches which consider and make provision for differences in prior knowledge and experience, styles of learning, home languages, competence in the language of learning, cultural backgrounds, as well as beliefs and practices (Brodie, Lelliott, & Davis, 2002a; Department of Education, 2002b; Sanders & Kasalu, 2004). In learner-centred methods, the teacher helps the learner to construct new knowledge by identifying their prior knowledge, scaffolding the learning of science concepts, and providing suitable activities during which learners can work alone and in groups to develop concepts and skills, and to explore and perhaps adjust their values and attitudes. Through the provision of these learning experiences, teachers provide the opportunities for learners to achieve the desired consequences at an appropriate level (Department of Education, 2002b).

Learners can recognise science better when they use the language of science through talking, reading and writing. Dialogue inspires discerning, especially when learners use their home language(s). Language can be used for examining purposes in cases where learners exchange ideas spontaneously with their teachers or with their peers (e.g. in groups, in performing science experiments). It can also be used for presentational purposes when the learners use the language in a more prepared and formal manner (Britton, 2002). For instance, learners can prompt significant clarifications of science texts and improve critical thinking skills (cognitive, estimates, implications, create decisions, etc.). As in language, learners can clear what they know in writing. If the learner cannot clarify a concept clearly in writing, it is possible that the learner does not clearly understand that concept (Freire, 2002). As mentioned above, speaking, reading and writing are language skills which are important in making reason of any learning activity in science teaching. In science learning, these skills strengthen the learners' scientific process skills (analysis, comparison, synthesis, inference, application, etc.) which show an important role in knowledge construction. It is logical to assume that learners can make more sense of what they are learning if they understand the language used in the learning process.

2.3.7 Establishment of the Learner-Centred Strategies

The term learner-centred has been frequently associated with excellence in NS teaching strategies and developmentally appropriate education (Carter, 2010; Paris & Combs, 2006). Learners participate actively in different learning tasks and are given opportunities to choose their own approaches (Carter, 2010, Meece, 2003; Wood, 2008). In comparison, teacher-centered approaches place more emphasis on learners following uniform instructions and directions on academic tasks. Educators generally believe that they need to be in control of the learning process, that some students are not naturally motivated or capable of learning, and that learners should work alone, following precise instructions (Paris & Combs, 2006; Wood, 2008). Daniels and Perry (2003) and Paris & Combs (2006) argue for the need for young learners to participate actively in class, noting that where teachers embraced learner-centred approaches, their learners were more motivated, placed a higher value on learning, and were more meaningfully engaged in their school work. They attributed these achievements to the fact that learners felt they were participating in interesting learning activities, that they could make their own choices, and that they were given opportunities to work with their classmates. In a similar vein, Daniels et al. (2001) found that best learning occurred when leaners were engaged, focused on problem-solving and working in small groups. Learner-centred approaches should recognize the individuals' own ability to think creatively and reflectively, and the value of democratic decision making and cooperative engagement in the construction of knowledge. By implication, learner-centred approaches should be collaborative and flexible, enabling learners' autonomy and creativity as they develop their own questions and processes for investigation. The integrated strategy for promoting the teaching of NS concepts was used in this study seeks to enhance the nature of open-ended dependable scientific review. By allowing learners optimum participation in the direction and environment of the learning process via stimulation of curiosity through discussion towards investigable questions, designing and executing open-ended investigations, and extending knowledge to learn science (Webb, 2009).

2.3.8 CHALLENGES TEACHERS AND LEARNERS ENCOUNTER IN THE TEACHING AND LEARNING OF SCIENCE CONCEPTS

According to Fakude (2004), teaching learners through their mother tongue might not work in science because most indigenous languages have not developed terminology to match scientific English. These challenges can, however, be addressed by borrowing the original scientific terms whilst using the mother tongue. Learners who are non-English speakers who are likely to think in mother tongue then translate their thoughts to English or Afrikaans. Usually, languages are culture specific, meaning scientific concepts may not be easily explained in vernacular (Fakudze, 2004). This means that if an educator teaches in the learners' mother tongue, the learners may encounter difficulties in examinations and later also at the higher level depending on what they choose to do, due to poor English language proficiency. So, the use of other nine official African languages can be impediments to learners wishing to advance in studying the sciences but whose home language is neither English. When one considers mother tongue and translates thoughts to English, in most cases the meanings may change, then the lack of vocabulary continues. This is just to illustrate the challenges that educators and learners alike face. The ethos of social constructivism rests upon educators adopting culture responsive pedagogies which accept plural worldviews (Turner, 2006). Teachers should, at the same time, empower learners with critical scientific knowledge. The challenge which remains is how teachers can teach NS concepts culture while empowering learners with critical scientific knowledge. Using argumentation to promote interaction in science involves justification of conclusions or claims by means of rational reasoning.

Jaménez-Alexandre and Erduran (2008) attribute the successful construction of scientific knowledge to involvement in argumentation. They further argue that argumentation relates to the power of persuasion, hence scientists use it in presenting their discoveries to fellow scientists. Masson, cited in Erduran, Simon and Osborne (2004) define argumentation as "*a form of discourse that needs to be appropriated by children and explicitly taught through suitable instruction, task structuring and modelling.*"

In teaching the Natural Sciences, learners are able to analyse and evaluate through argumentation. This ties together with being responsible for one's learning by knowing how to know and what needs to be updated (Kgaffe, 2001). Learners are supposed to construct scientific knowledge about the natural world through experimentation, presentations and argumentation, as they present their findings. Tiberghien, in Jamenez-Aleixandre and Erduran (2008) further extrapolates the three goals of argumentation in science education namely: bringing to the fore, the knowledge of the nature of science; developing responsible citizenry among participants; as well as empowering participants with scientific language when thinking and writing. This kind of learning, which is participation based through argumentation, closely imitates how scientists engage each other (Dada, Dipholo, Hoadley, Khembo, Muller & Volmink,2009).). There are insurmountable advantages of adopting argumentation in a multi-science class. These entail learners' prior knowledge bearing on new science concepts, development of critical thinking through discussions, sharing of ideas during group work, as well as language development and meaningful acquisition of scientific knowledge.

2.3.9 LANGUAGE PROBLEMS IN SCIENCE LEARNING

Language, as a means of communication, plays a significant role in all teaching and learning. The teaching-learning process involves interaction that occurs between the teacher and the learner using language in many instances. Learning science involves learning the language of science which is complex, abstract and highly specialised, with grammatical metaphors and lexical density (Jones, 2000). Certain terms are modified, and this influences the language of science. The new technologies (e.g. computers) also influence the way knowledge is presented and communicated. They bring about a transformation in the way in which scientists present and produce knowledge, and how they communicate the information among themselves to convey acceptable meanings (Jones, 2000). For example, learners can do the following language related activities in a science classroom: taking notes, reading a textbook, writing laboratory reports, completing Science projects with language components, and making presentations, and so on. In relation to science teaching and learning, learners should be able to use or interpret the verbal and visual language of science effectively.

When learners learn in a language that is not their mother tongue, learning then becomes more difficult. 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 (Baker & Jones 2005). When learners are required to learn content in a second language, they are faced with the problem of content literacy (Van der Poll & Van der Poll, 2007). When learners have to use a language that they are not proficient in, then mastering content (both practical and theoretical) of a subject becomes very difficult (Van der Poll & Van der Poll, 2007). This, in turn, affects the learners' performance in Sciences because language plays an important role in the understanding of technical terms in a subject (Van der Poll & Van der Poll, 2007).

For learners who are not taught in their mother tongue, the practical aspects of Natural Sciences become important. With the availability of the right resources, educators are able to demonstrate experiments which can help the learners, even those being taught in their mother tongue, to gain a visual experience of the processes that are taking place, and thereby improve their understanding. Oyoo (2005) maintains that science words form the distinctive body of concepts which mark out science from other subjects, or different school science subjects from each other for example NS as distinct from Life and Living. Wellington and Osborne (2001) further state that one of the major difficulties in learning science is learning the language of science. However, this is not a message that has reached the science teaching profession. The science profession needs to be aware that learning the language needs to be a major part of science education, and that language is a major barrier to the learning of science. Prophet and Badebe (2006) emphasise that to learn in the domain of science, the learner must acquire a new language without which, understanding cannot be achieved. This indicates that for the second language learner, two major learning difficulties sit side by side and interfere with each other: learning to use the language of instruction, commonly English, at the level required for learning academic content, and learning to use the language of science to decipher what is being said (Prophet & Badebe, 2006).

Existing literature identifies four major English Medium of Instruction (EMI) challenges facing teachers. These are; teachers' language abilities, students' proficiency, appropriateness of methods, and availability of resources (Mohamed, 2013). Learners who are English second language speakers have difficulty in expressing themselves effectively, especially in paraphrasing, searching for words, and refining statements on the teaching of Natural sciences concepts. Such factors potentially result in detrimental effects on students' learning through less content coverage and knowledge loss (Coleman, 2007).

Shohamy (2012) echoes these concerns in the context of language. Shohamy (2012) posits that more often than not, teachers have high knowledge in a content area but not in the language of learning and teaching. This results in difficulties to transfer this knowledge on to the learners. Qwase, cited by Mgwebu (2009), identifies the various challenges faced by educators as the capacity of teachers to translate the policy and methodology to make an impact and succeed. Since the introduction of the education, the performance of schools has deteriorated every year. Significantly, South African schools are complaining about learner performance reflected in the international benchmark tests such as the TIMSS 1999-2003 (House, 2002; Mullis et al., 2009).

In 2008, Minister Pandor, pointed out the challenges and the need for assistance in the teaching and learning in schools as "A call to all South Africans to join hands with the Department of Education to improve learning in these crucial areas like science and mathematics" (DoE, 2008). It has been reported that out-dated teaching practices and lack of basic content knowledge have resulted in poor teaching standards (Fleisch, 2008). The poor standards have also been intensified by a large number of under-qualified or unqualified teachers who teach in overcrowded and non-equipped classrooms. The combination of all these factors has, in turn, produced a new generation of teachers who are further perpetuating the cycle of mediocrity (DoE, 2008). The National Teacher Education Audit of 1996 followed by the mathematics and science Audit of 1997 produced factual and statistical revelations about teachers and teaching in these areas. Whilst policies and programmes have been produced on a general scale, very little has happened at a systemic level to address the challenges of providing quality mathematics and science teachers.

In fact, the mathematics and science audit revealed that more than 50% mathematics and 68% science teachers have had no formal subject training (DoE, 2008). The problem of inadequate training was particularly identified in the general education phase of the schooling system (DoE, 2008). The Education for All (EFA) 2000 assessment (2005) also reported that, despite approximately 85% mathematics educators. being professionally qualified only 50% have specialised in mathematics in their training. Similarly, with 84% of science educators professionally qualified, only 42% are qualified in science. An estimated 8 000 mathematics and 8 200 science educators therefore, needed in-service training to address their shortcomings in these subjects (DoE, 2008). Another problem is that very few students graduating with mathematics and science choose teaching as a career. A consequence of this is a vicious cycle of not many students taking mathematics and science related subjects at high school level, resulting in an under-supply of educators. In some instances, this has resulted in schools not offering mathematics and physical science (DoE, 2008). Even those that offer these subjects, do not have facilities and equipment to promote effective teaching and learning. This situation has resulted in the teaching of science remaining at a theoretical level without any experiments to enhance understanding and application of knowledge (*DoE, 2008*). To address these problems, such as under-qualified teachers and few students taking mathematics and science related subjects, several initiatives and programmes have been developed at national and provincial levels, as well as by higher education institutions. From the government side, a typical example is the setting up of Dinaledi schools, which are to be increased to about 400. The Dinaledi Focus Schools Project is part of the National Strategy for Science, Mathematics and Technology, to increase the number of learners studying mathematics and science in high school; to increase the number of higher grade learners in these subjects, especially girls and formerly disadvantaged learners; to increase the pass rate and achievement in mathematics and science in these grades; and to develop the capacity of the mathematics and physical science teachers (Western Cape Department of Education,2010).

Universities have also introduced bridging courses aimed at improving the content knowledge of mathematics and science students entering university. What has been shown is the fact that a number of issues impact on the teaching and learning of mathematics and science throughout the school system in South Africa. The present study, based on a USAID-TELP sponsored research project, was undertaken to explore some of the factors that possibly contribute to the lack of success in mathematics and physical science among lower grades.

2.3.8.2 The problem in context of Naturel Science

Although the study focuses on Grade 7 (primary school learners), a closer look at high school to university level performance reveals the problem far more. Grade 12 results are reflective of the problems because these can be analysed in many ways, for example, using school-related variables, gender related issues of learners and educators, and resources available at individual schools. Also, such analyses are relatively fair because national standards are maintained through the results being examined and moderated by external bodies, to minimise bias (Heugh, 2003). This means that all schools at least write the same examinations and therefore, comparisons based on the results should generally be valid. Such comparisons are also useful in indicating the factors that lead to poor performance.

A second analysis, intended to provide a provincial perspective, focused on the 2003 matric results. It should be noted here that the two respective years were only used for illustrative purposes. However, these years, in many ways, exemplify performance in any other year. That is, choosing these particular years, does not in any way, distort what has been happening both in the district and provincially. In effect, any two years for example 2003 and 2004 could have been chosen. However, going back in years provides a better illustration of the history of the problems investigated in this study. Whilst this study is not concerned about results and examinations, it is worth pointing out, however, that the examinations and results for 2003 were particularly criticised for their poor quality. This point is raised here because it also illuminates problems experienced in the teaching and learning context of sciences. Part of the criticism related to scepticism about a 25% national pass rate jump over a five-year period. In fact, critics did not believe that all the provinces could produce this sudden improvement. Regarding the criticisms, an editorial in the Sunday Times (2004) pointed to a strong and growing public perception about the standard of performance in Grade 12 being lower than in previous years. To this effect, Jacobs (2004) does not see the value of the passes. In his argument, he points to the fact that in critical subjects where learners have to show excellent capacity, more than two thirds fail in higher grade mathematics and about 50% failed in physical science.

2.3.8.2 Challenges encountered by learners when learning NS concepts

Many learners struggle in science education at school because science exists in a cultural context and teaching and learning science is often a cross-cultural activity (Cobern, 1996 cited by Marshall, 2014). Some concepts of science that learners learn in class are not familiar to them and have no relevance to their daily lives. According to the learners, they only hear the science concepts in the classroom, but they cannot visualise them (Akatguba & Wallace, 1999 cited by Marshall, 2014). However, making science relevant to the everyday lives of children is a problem, but it may “require a variety of other factors, a classroom environment in which students can be actively involved in making meaning of the information within a relevant, real-life context" (Dass, 2001). As the learner interprets the science, he/she is being taught, this interpretation is influenced by prior knowledge. The teacher must not expect the learner to understand science in a manner similar to that of the learner who uses English as home language understands science. It is reasonable to expect culture-specific understandings of science (Cobern, 1996 cited by Marshall, 2014). One should not expect African students to understand science exactly the same way students in Western countries understand science. It is important for science teachers to understand the socially grounded views about the world that the learners bring to the class, and how these views are supported by the learners' cultures (Cobern, 1996 cited by Marshall, 2014).

The Natural Sciences curriculum is modelled after what scientists do. It is geared towards learners who are curious about their world, the natural phenomena and the importance of responsible use of scientific knowledge in solving social problems (CAPS, 2011). All this can be achieved when educators facilitate learning through the selection of suitable teaching methods. Therefore, the science teacher is seen as someone who, through careful adoption of suitable teaching approaches, evokes the curiosity and excitement in learners about their natural environment and the world at large. According to Sessoms (2008), current social trends require citizens to be more analytical thinkers and to synthesise information. Current teaching practices must develop these higher order thinking skills. Sessoms (2008) reiterates the critical role of teachers in the development of learners who can critique situations. This starts with teachers adopting the constructivist instructional approach. The constructivist teaching approach is premised on the belief that learners are not blank slates to be written upon or empty vessels to be filled when they come to school. Moreover, the use of tools helps to maximise restructuring of conceptions through meaningful engagement of learners and the teacher. Consequently, having interactive classrooms is a way of moving away from the teacher centred approach towards effective teaching and learning as propounded by social constructivists.

2.3.8.3 Challenges encountered by teachers when teaching NS concepts

Christie et al. (2007) state that one of the great challenges facing educators today is motivating learners to read science words. Powell and Aram (2007) urge educators to encourage learners to actively seek out answers for their questions through investigation or further reading, thereby motivating them to read to learn difficult science concepts. When children have constructed scientific ideas based on their own experiences, the opportunity exists to encourage them to read further to clarify, confirm or extend their findings and formulations. Powell and Aram (2007) continue to suggest that scientific concepts and open-ended investigations are important catalysts for further reading as hands-on investigations lead to questions which cannot be answered through more investigation. According to Barrow (2010), it is the learners' interest which initiates inquiry, and which leads to questions which can be used to form the basis of the learning process and motivate learners to want to learn more (Barrow, 2010).

2.3.9 Implications for Science Education

The Department of Basic Education's (DBE) Curriculum and Assessment Policy Statement (CAPS) for Sciences (2011) suggests that teachers of Sciences should be aware that they are also engaged in teaching language across the curriculum. This is particularly important for learners for whom the Language of Learning and Teaching (LOLT) is not their home language. It is important to provide learners with opportunities to develop and improve their language skills in the context of learning Natural Sciences concepts. It is critical to afford learners opportunities to read scientific texts, to write reports, paragraphs and short essays as part of the assessment, especially (but not only) in the informal assessments for learning. This indicates that incorporating language strategies in science classrooms is important. According to Farrel and Ventura (2010:243), in science education, interest in word understanding first gained momentum in the early 1970s when Gardner (2009) cited by Hlabane (2014) conducted an analysis of the vocabulary skills of students attending secondary school. As part of their involvement in the Australian Science Education Project, Gardner tested the understanding of over 600 words among 7000 pupils from 39 different schools. He/she found that some of the most popular words used by teachers of science in the classroom were simply not understood by the students. The result was a remarkable one and it triggered a series of similar investigations in the years to follow, right up to the present time (Hlabane, 2014).

Wright and Bilica (2007) stipulate that modern educational theory, as evidenced in the conceptual change-learning model encourage science teachers to focus less on factbased, rote learning and more on conceptually driven teaching. This requires teachers to plan teaching by first getting information about learners' prior knowledge, and then using understandings to structure the lesson (Jaipal, 2001; Orgill & Bodner, 2004; Ren Dong, 2002). Jaipal (2001) further proposes that besides learners' prior knowledge and experiences, sign systems, especially language, and interpersonal relations between teachers and learners, mediate learning. Teachers have to investigate students' knowledge. In order to assign appropriate methods for teaching science, learners' misconceptions need to be identified (de Jong, 2005). Some theorists hold the view that teachers should deal, not only with learners of high abilities or high motivation for science, but also look at the learners' cognitive and affective dimensions (de Jong, 2005). Science educators must consider a number of issues including their teaching approaches, and techniques, interpersonal interactions, to ensure the effectiveness of science teaching, so that they motivate their learners towards acquiring necessary scientific skills, scientific knowledge, values and attitudes and provide high quality science education for all learners (Howe, 2003). Sciences deal a lot with problem solving. This is supported by DBE (2012: 11) that Natural Sciences promotes knowledge and skills in scientific inquiry and problem solving; the construction and application of scientific and technological knowledge; an understanding of the nature of science and its relationships to technology, society and the environment. Sciences prepare learners for future learning, specialist learning, employment, citizenship, holistic development, socio-economic development, and environmental management. Learners choosing Sciences as a subject in Grades 7-12, including those with barriers to learning, can have improved access to: academic courses in Higher Education; professional career paths related to applied science courses and vocational career paths. Sciences play an increasingly important role in the lives of all South Africans owing to their influence on scientific and technological development, which are necessary for the country's economic growth and the social wellbeing of its people (Hlabane, 2014). The implication of the above is that learners need Cognitive Academic Language Proficiency (CALP) skills if they are to disseminate science knowledge successfully. Basic interpersonal communication skills allow learners to converse fluently in demanding natural situations, while cognitive academic language proficiency enables learners to understand academic concepts and perform higher cognitive operations required of a person at a school or institution of higher learning. Physical sciences as a subject, requires learners to have higher cognitive and academic language skills since it is a subject with its own language (Hlabane, 2014).

Prah (2005) defines the language of learning and teaching as the language in which basic skills and knowledge are imparted to the population and the medium in which the production and reproduction of knowledge take place. This means that the language of learning and teaching should be an enabling tool in the teaching and learning process. It ought to help learners react to different facts and viewpoints in order to construct a new view of the world, including the meanings they attribute to the new concepts they are introduced to, and the values they attach to them (Namuchwa, 2007). The implication of the above statement is that the language of learning and teaching should, of necessity, be the one which is familiar to the educator and the learner if communication is to be effective. However, it seems the policy makers in South Africa take the learners' language ability for granted and perceive any gaps in learning to be merely a result of educators' and learners' lack of commitment; by promoting English, a former colonial language as a language of learning and teaching. The Natural Sciences learning area incorporates the sustainable use of the earth's resources, as well as preparing learners to participate in a democratic society, where human rights are valued and environmental services are promoted (Winter, 2009).

2.3.10 Teaching and Learning of NS Concepts

According to Lederman, Lederman and Bell (2003), teaching and learning of scientific concepts is viewed as an essential component of all current science curricula. Science educators have historically been concerned with students' ability to apply their scientific knowledge to make informed decisions regarding personal and societal problems. The ability to use scientific knowledge to make informed personal and societal decisions is the essence of what contemporary science educators and reform documents define as scientific literacy. However, many scientists and science educators have difficulty agreeing on what scientific literacy is, let alone knowing how to teach and assess it (Makgato & Mji, 2006). Mashile (2001) argues that it is at the school science level where learners should begin preparation to engage in a world where industrial and economic development progresses in a socially and environmentally sustainable manner. From a global perspective, Fensham (2008) states that the current quality of school science education has "never before been of such critical importance", due to the demands made on citizens to make responsible, democratic decisions. In response to this reality, Fensham (2008) notes that consensus has been reached in the science education community that there is need to focus on scientific literacy which emphasises scientific knowledge and applications. However, a more recent consensus that has emerged within sectors of the science education community is the need to focus more on the literacy aspects of scientific literacy (Norris & Phillips, 2003, Yore, Bisanz, & Hand, 2003).

For Norris and Phillips (2003), scientific knowledge encompasses both a fundamental and derived sense of science. The distinction that they draw between the senses of science is that the fundamental sense requires proficiency in science language and thinking and refers to the use of language in science contexts. In comparison, being proficient in the derived sense signifies being able to make informed judgements on scientific societal issues and deals with understandings or abilities relative to science (Norris & Phillips, 2003). Norris and Phillips (2003) maintain that by strengthening learners' fundamental sense of science, such as their ability to read, write and communicate; the overarching goals of understanding the derived sense of science, are achieved. Furthermore, if students are to participate and employ scientific thinking in a wide range of social contexts, communication abilities should be furthered through practice in debates, discussions and the application of scientific concepts to provide effective argumentation and clarify relationships between claims, evidence and warrants (Hurd, 1998; Osborne, Erduran, Simon, Monk & 2001; Webb, Wereiams, & Meiring, 2008). As such, the argument is that any science curriculum which focuses on concepts, content and memorisation, should be challenged and transformed by addressing scientific literacy and by empowering people to be fluent in the discourses of science (Yore & Treagust, 2006).

2.3.9.2 Inequalities of well-resourced and under-resourced schools

Rogan and Grayson, (2003) state that most schools in South Africa are still suffering from inequalities when it comes to provision of resources. Therefore, Rogan and Grayson (2003) note that it is necessary for the theory of implementation to take diversity of schools into account. Moreover, Bantwini (2009)) points out that the implementation of requirement mentation of condition varies widely from class to class and school to school. This means that the needs for previously disadvantaged schools cannot be the same when compared to previously advantaged schools. More on that, Parker (2006) states that schools in previously disadvantaged areas are still faced with acute shortage of resources, overcrowded classrooms and discouraged and under-trained teachers. Furthermore, Rogan and Grayson (2003) note that in South Africa schools differ in terms of quality, knowledge and skills of teachers when it comes to science. Furthermore, Rogan and Grayson (2003) argue that since some schools have better resources than others, both physical and human; they are better placed to benefit of the new curriculum in South Africa. Rogan and Grayson (2003) point out that that there is a tendency in South Africa of not taking into consideration the existing diversity of schools and just impose complex and comprehensive changes in systems that may or may not be ready to cope with them. Therefore, many schools seem to be having difficulties when it comes to the implementation of curriculum reform because they do not have capacity that can support all the changes in the curriculum. The main problem with the curriculum is its implementation is based on the assumption that all schools are the same and would therefore, benefit from the same kind of in-service training and strategies. This may account for the increase of differences in the effect of curriculum change in many schools in South Africa. Rogan and Grayson (2003) in the theory of implementation, state that the construct capacity to support innovation is an attempt to understand and elaborate the factors that can support or inhibit the implementation of new ideas and practices in a system such as a school. Therefore, it is necessary to recognise that not all the schools have the capacity to implement changes to the same extent.

Ogunniyi (2002) notes that performance in science in many African countries, is generally poor. Compared to their colleagues in Europe or America, students in African countries constitute disadvantaged or underachieving groups in as far as science education is concerned. In his article on developing human capital in Africa, Ogunniyi states factors that bring about poor performance in science in many African countries (Ogunniyi, 2002). Among the factors mentioned by Ogunniyi(2002) are government, society, teacher, school, subject matter, examination, family, and student related issues. This study focuses on issues to do with students' learning. Two aspects of learning that form the basis of this study have been cited by Ogunniyi (2002). According to Ogunniyi (2002), students have poor "study habits" and prefer rote learning rather than problem solving.

Black (2006) endorse Ogunniyi's (2002) findings about students' preference for rote learning when they report from their extensive survey of education in Uganda, that students and early school leavers consider remembering rather than problem solving to be the main trait of science learning. Peacock (1995) cited by Dzama (2003) sees the problem of learning science in Africa as one of dissonance between concepts of learning embedded in current science curricular and the concept of learning traditionally held by students and their parents. The factors that contribute to failure in students' learning in African countries have further been summarised by Grayson (1996) cited by Dzama (2003) as:

- inadequate background in the language of instruction and in teaching of science,
- use of inappropriate learning styles,
- behaviours that may have a detrimental effect on their learning,
- absence of prerequisite cognitive skills in the learner,
- lack of practical skills, and
- absence of metacognitive awareness.

In relation to the factors listed above, studies have shown that students' fluency in the language of instruction is an important factor in determining achievement (Human Vogel & Bouwer, 2005). Similarly, the importance of mathematical ability in learning science has been widely acknowledged (Derrick & Derrick, 2002). What appears to be missing from Grayson's (1996) list is the epistemology of science. A plethora of studies has in recent years suggested that students' epistemological beliefs about science and science learning are significantly related to their orientations to science learning and integration of scientific knowledge (Louca, Elby, Hammer & Kagey, 2005; Leach; Tsai, 2003; Songer & Linn, 2001). May and Etkina (2002), writing from the perspective of physical science, state in this connection, that students' epistemological beliefs are important because "they influence motivation and affect the selection of learning strategies" (Human Vogel & Bouwer, 2005).

2.3.10 PROBLEMS IN SCIENCE EDUCATION

Most researchers recognise the language problems associated with science education. Yore and Treagust (2006) mention a three language (home language, instructional language, science language) problem which exists for most science language learners. They argue that no effective science education programme would be complete if it did not help learners to discuss science and to comprehend a full range of science text. They note that learning to talk, read and write science needs teaching about language, since acquisition of language skills enable learners to argue meaningfully about science issues. In most South African schools, the language problems are exacerbated in science because learners are taught science in a language which is not their mother tongue (Setati, et al., 2002). Learners come to school with informal ways of talking and teachers have to move them from informal spoken and written language to formal language (Setati et al., 2002). They further state that in multilingual classrooms, the movement from informal spoken language to formal written language (discourse specific talk) is complicated by the fact that learners' casual talk may be in a language that is not the learners' language of learning and teaching. Another problem with science education is the misconceptions that learners have about science (Black, 2006). Chimoro (2004) argues that children bring into the classroom socio-cultural characteristics from their environment which may create a wedge between what they are taught and what they learn.

Black (2006) also mentions that many American science textbooks add to children's misconceptions as many textbooks do not explain scientific concepts correctly. To change learner's misconceptions, Black (2006) amongst a plethora of other science educationists, suggests that teachers need to be competent, patient and make connections between what they learn in science classrooms and what they already know. Chimoro (2004) concurs with Black and state that science learning should emphasise the need to begin teaching with knowledge and experience of the learners and build that base to assist the development of their understanding of the world.

2.3.11 STUDIES ON SCIENCE AND LANGUAGE OF TEACHING AND LEARNING SCIENCE

In this section, different studies that have been conducted in relation to Science and language of teaching and learning science are considered. According to Gudula (2017), the challenge that engulfed South Africa is the disappointing performance of the learners at the school level in Mathematics and Sciences. It has been recognised for decades that there is widespread underachievement in Sciences and Mathematics education in South Africa. Recent research on science literacy suggests that teacher education and professional development strategies should assign a more important role to language in the learning and teaching of science (Yore & Treagust, 2006), while a number of investigators have reported on strategies for improving reading, writing, discussing and doing science.

Most researchers recognise the language problems associated with science education. Learners come to school with informal ways of talking, and teachers have to move them from informal spoken and written language to formal language. Setati, et al., (2002) argue that children bring into the classroom, socio-cultural characteristics from their environment which may create a wedge between what they are taught and what they learn. In one study by Abell, Martini and George (2001), two sections of an undergraduate course in elementary science education were observed during an extended investigation, in which students made observations of the moon and tried to develop explanations for what they saw. Students worked in groups, were engaged in many aspects of the process of science and were asked to reflect on their own learning regarding the moon. Eleven student journals of the experience, along with interview transcripts from these students, were analysed for student learning regarding observation in science, the role of creativity and inference in science, and social aspects of science. In another study by Moss (2001), five 11th and 12th grade students, with a range of academic achievement, taking an environmental science class, were interviewed six times over the course of a year. The class was project-based and engaged students in data collection for real scientific research. Interviews focused on students' views of selected aspects of the nature and process of science. The researcher coded and interpreted transcripts of the interviews. In the following sub-section, the researcher looks at some of the studies that connect science knowledge delivery to the language in which science is adopted as a popular language and the language of the learners, as Home-language (Gudula, 2017).

2.4 CHAPTER SUMMARY

This literature review chapter has shown that there are challenges in teaching and learning of NS concepts to English second language learners specifically grade 7 class, the exit class to high school. Learners find some difficulties when learning in other languages and can understand better when they are taught in their mother tongue. The literature review touched on the CAPS documents and the National Education Policy of 2007, because they are the main policies that act as guides of what schools are supposed to do when it comes to teaching and learning. The literature also mentioned the fact that educators who were teaching Natural sciences concepts in Grade 7 did not use the same method in terms of terminology in class. In other words, they taught using their own terms instead of using one terminology when explaining certain concepts so that there is uniformity among the educators.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The previous chapter explained the role of language in the learning of NS concepts. The theories of learning in a second language and for teaching disadvantaged learners were aptly scrutinised to provide a conceptual framework underlying this study. The discussion on theory appropriateness and the weakness of certain theories, namely; the Social Constructivist Theory, brought about the realisation that some approaches to teaching may or may not be suitable for specific groups of learners. This information also brought to the researcher's attention that the educator's perception about the approaches is very crucial and that how they are related to the learning process can either make or break the student's learning. The aim of this chapter is to discuss the educational setting of learners as part of the learning environment of this study. The researcher wishes to describe the environment which the target research group comes from, that is, their primary school setting, the effects of history on their educational setting, home background, geographical location as well as the general cultural factors impacting on their learning of Science in relation to their past educational experience.

In this chapter, the researcher provides a discussion of the research approaches which were adopted to investigate the teaching of Natural sciences concepts to English second language learners in primary schools and implications for science education. It discusses how the research was conducted. Firstly, it begins with an explanation of the research design, that is, the mixed methods approach of inquiry, used to find answers to the research questions of this study that provides justification of the choice of the research design. Secondly, it describes the research setting, participants, and the choice of NS as the content subject for the study. Thirdly, it discusses the data collection process and tools for each phase, that is the quantitative phase by means of a questionnaire, and qualitative phase by means of interviews and classroom observations. Fourth, the chapter describes various methods employed to analyse data obtained from both the quantitative and qualitative phases and shows how both types of data were integrated. This is followed by a description of the implementation of the pilot study including measures that was taken to ensure validity and reliability. Finally, a discussion of ethical considerations taken is presented. This is in keeping with what Leedy and Ormrod (2013) refer to when they say to answer some research questions, we cannot skim across the surface. We must dig deep to get a complete understanding of the phenomenon we are studying.

3.2 RESEARCH PARADIGM

Blanch, Durrheim and Painter (2006) define a paradigm as an all-encompassing system of interrelated practice and thinking that defines for researchers, the nature of their inquiry along three dimensions: ontology, epistemology and methodology. These three dimensions of a paradigm entail a set of believes, values and methods influencing what should be studied, how it should be studied, and how results are interpreted. Bogdan and Biklen (cited by Mackenzie and Knipe, 2006) also define research paradigm as a loose collection of logically related assumption concepts or propositions that orient thinking and research'. The methods of data collection depend on the paradigm and the research questions. As Mackenzie and Knipe (2006) point out, it is the paradigm and research questions which should determine which data collection and data analysis methods (qualitative, quantitative or mixed methods) are appropriate for the study. In this form of research, the researcher relies upon the participants views of the situation being studied, and recognises the impact on the research of own background and experiences.

Lincoln, Lynham and Guba (2011), Creswell (2014), Babbie (2010) and Mertens (2005) posit that a paradigm is essentially a frame of reference with which to observe and understand the world. This research study adopted the pragmatist paradigm. Pragmatism is most commonly associated with mixed methods research (Teddlie & Tashakkori, 2009). The paradigm offers an alternative worldview to that of positivism/post-positivism and constructivism and focuses on the problem to research and the consequences of the research (Creswell & Plano Clark, 2007; Miller, 2006). When regarded as an alternative paradigm, pragmatism sidesteps the contentious issues of truth and reality, and accepts philosophically, that there are singular and multiple realities open to empirical inquiry, and it orients itself towards solving practical problems in the real world (Creswell & Plano Clark, 2007). This paradigm allows the researcher to be free of mental and practical constraints imposed by the forced choice dichotomy between post-positivism and constructivism.

Researchers are not prisoners of a research method or technique (Creswell & Plano Clark, 2007).

The use of this paradigm is suitable as the study sought to examine the teaching of Natural sciences concepts to English second language speakers in selected primary schools. Pragmatism allowed the researcher to employ different but, interrelated strategies in interacting with respondents and participants within their contexts, to gain insights on how teachers teach Natural sciences concepts to English second language speakers.

Morgan (2007) indicates that, rather than assessing any new approach strictly on its own merits, the implications of that approach should be pondered within the realms of an ongoing research context in which researchers have established commitments to other sets of beliefs and practices or research paradigms. Thus, established qualitative and quantitative research paradigms, and the paradigmatic arguments for mixing them for this research, were considered. Researchers' beliefs about the research questions to ask and use of methods to address these questions, are generally based on their stances about what can be known and how one acquires such knowledge. These stances are important components of researchers' ideas about reality and the nature of knowledge as reflected in their worldviews (Morgan, 2007). Quantitative research is associated with the view of a social world that is external, independent, fixed or objectively real, whereas, qualitative research is linked to ideas of a world that is constructed, subjectively experienced, and the product of human thought as expressed through language (Opie, 2004). Each of these have epistemological assumptions about which knowledge is deemed valid, which in turn, impacts on the type of knowledge or research evidence that is sought (Cohen, Manion & Morrison, 2007; Opie, 2004).

According to Creswell (2003), quantitative research has traditionally been linked to the so called "scientific method", also identified as positivist or post-positivist research, empirical science and post-positivism. As its name suggests, post-positivism specifically refers to the thinking that followed positivism, which challenged the notion of an absolute truth awaiting discovery, and recognised that there cannot be absolute certainty about knowledge claims when studying human behaviour and actions. Post-positivism does reflect a deterministic philosophy in which causes do probably determine outcomes, a stance which is often reflected in the design of the research associated with this paradigm.

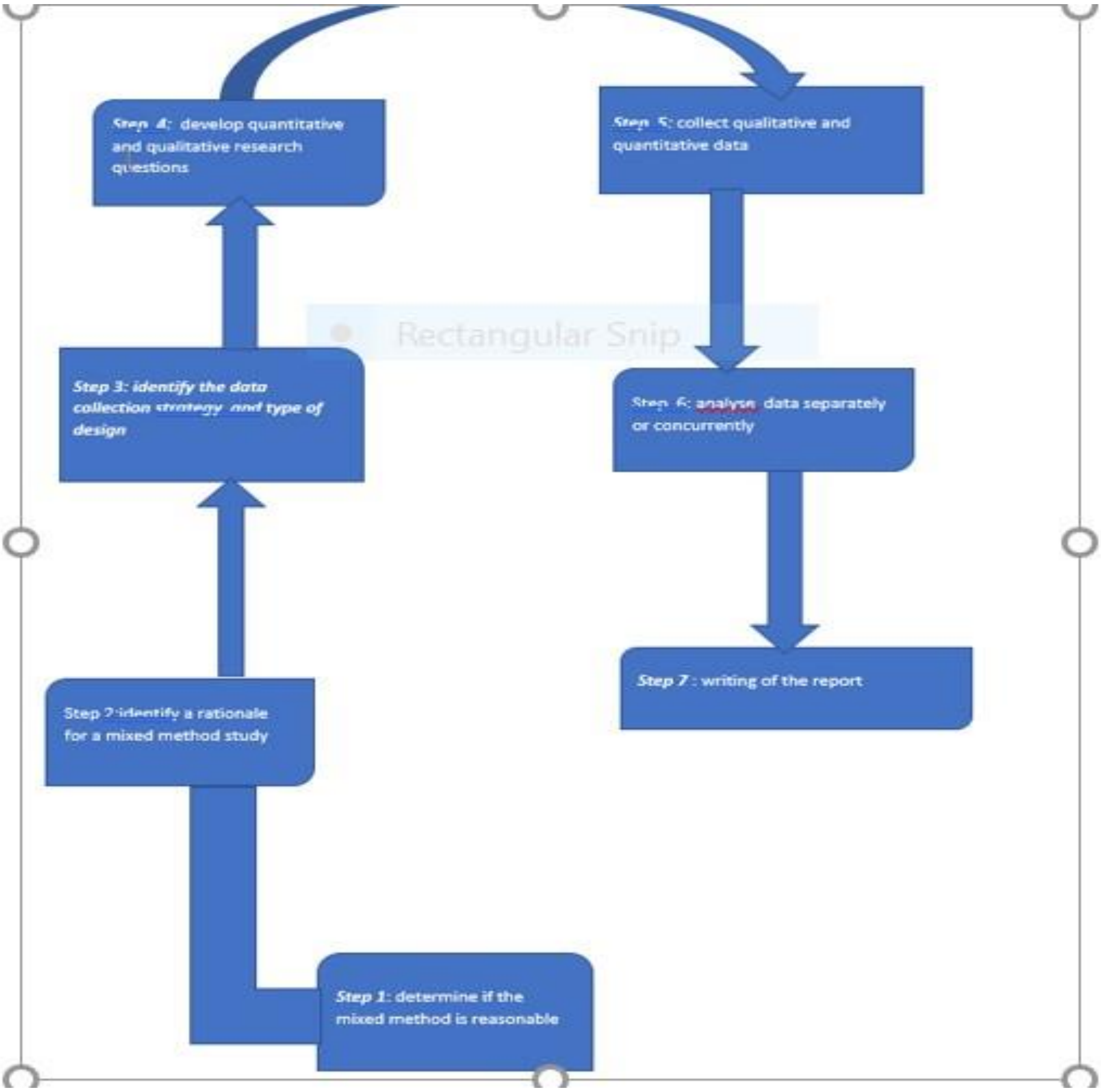
Research data, evidence and rational considerations shape knowledge, and researchers collect information on instruments based on measures completed by participants or researcher recorded observations. The goal is to develop relevant, true statements, which can explain the situation of concern or which describe causal relationships of interest (Creswell, 2003). Pragmatism, in its many forms, originated from the work of Pierce, James, Mead and Dewey (Creswell, 2003), and, as an epistemological stance for this research, ensconces these ideas and those introduced in the sub-section above most appropriately. Knowledge claims are thought to arise from actions, situations and consequences rather than from backgrounds, as in the case of post-positivism. The concern is with applications and solutions to problem situations, and, the problem is more important than the actual methods chosen (Creswell, 2003).

Pragmatism is further based on the idea that a false dichotomy exists between quantitative and qualitative research and that researchers should make the most efficient use of both research paradigms to understand educational and social phenomena (Onwuegbuzie & Leech, 2006). Pragmatism is not committed to any one philosophical system of reality and knowledge (Creswell, 2003). Knowledge from the pragmatic viewpoint is considered to be both constructed and based on the reality of the world we experience and live in (Johnson & Onwuegbuzie, 2007). Both qualitative and quantitative research methodologies were integrated into this research in the form of a mixed method research design. Leech and Onwuegbuzie (2005) identify rationales for mixing qualitative and quantitative approaches as; participant enrichment, instrument fidelity, treatment integrity, and significance enhancement.

Participant enrichment refers to increasing the number of participants in the research. Onwuegbuzie and Leech (2006) contend that the larger the sample, the more reliable and valid the research findings. In terms of this rationale, the sample used for this study was limited to township primary schools doing NS to English second language learners in the East London district. Respondents from each school completed the questionnaire.

Instrument fidelity refers to maximising the appropriateness and/or utility of the instruments used in the study. For this study, three instruments were used, namely; questionnaires, interviews and observation. The questionnaire for grade 7 NS teachers and learners was appropriate in as far as it assisted the researcher to solicit biographical information. The NS HoDs were solicited information regarding the head of department instructional leadership practices. *Treatment integrity* refers to mixing qualitative and quantitative research methods to assess the fidelity of interventions, treatments, or programmes.

Significance enhancement refers to maximising the researcher 's interpretation of data.



The above figure, Figure 3.1 shows the steps in the process of conducting a mixed methods study.

The 7 steps indicated in the above figure were observed from the planning stage of this research study through to the data analysis stage. It also emphasises the fact that, rather than viewing various research methods as part of an incompatible quantitative/qualitative dichotomy, the researcher struck a balance.

3.2.2 Pragmatist Paradigm of this study

This research study is situated within the pragmatist paradigm, which holds the position that the research question, or set of questions, in a specific problem space should guide the researcher in choosing the most suitable methodological approaches to addressing the enquiry (Creswell & Plano Clark, 2007; Johnson & Onwuegbuzie, 2006; Tashakkori & Teddlie, 2003). Within the context of the study, knowledge is using generated primitive evidence to gain a deeper understanding of the science realities on which the evidence is based. The generation and analysis of the quantitative data places this aspect of the research within a positivistic framework, yet qualitative instruments, analysis and attempts at understanding 'social reality' place this study within the interpretive paradigm. The use of both qualitative and quantitative methods assists in providing a clearer understanding of the data (Creswell & Plano Clark, 2007).

Pragmatism is generally regarded as the metaphysical foundation for mixed method research (Creswell & Plano Clark, 2007; Johnson & Onwuegbuzie, 2007, Tashakkori & Teddlie, 2003). Bulmer (1983) stresses the importance of choosing research methodology that is appropriate to the research objectives and urges researchers to ask whether the chosen methods adequately produce the kind of data needed to answer the questions posed in the study. The pragmatist paradigm embraces the position that the research question, or set of questions, in a specific problem space, should guide the researcher in choosing the most suitable methodological approaches to addressing the enquiry (Creswell & Plano Clark, 2007; Johnson & Onwuegbuzie, 2006; Tashakkori & Teddlie, 2003). Johnson & Onwuegbuzie (2004) and Tashakkori & Teddlie (2003) suggest that researchers within the pragmatist tradition place more importance on the research question than the method or paradigm that underlies the investigation. Additionally, they believe that a practical combination of methods, such as a mixed methods approach, may offer greater insight, or the best chance of answering specific research questions. As noted previously, this study employed both qualitative and quantitative methods, and therefore uses a mixed-methods approach.

3.3 RESEARCH APPROACH

Research approaches are grounded in the philosophical assumptions underpinning existing research (Oyoo, 2008). Traditionally, objective and subjective theories have been conventionally distinguished, as purely quantitative approaches and purely qualitative approaches respectively (Johnson & Onwuegbuzie, 2006). However, a growing number of mixed method researchers suggest that research need not be restricted to exclusive paradigms and limited methodological practices (Creswell, 2003; Creswell & Plano Clark, 2007; Greene, Caracelli, & Graham, 1989; Tashakkori & Teddlie, 2003). In comparison to the above distinction, they state that one should choose a combination of methods that provides sufficient evidence for answering the research question (Jang, McDougall, Pollon, Herbert, & Russell, 2008). The mixed method approach combines a distinct set of ideas and practices, which separates it from the traditional qualitative and quantitative approach. Leading mixed methodologists such as John Creswell, Jennifer Greene, Burke Johnson, David Morgan, Anthony Onwuegbuzie, Abbas Tashakkori, Charles and Teddlie offer defining characteristics of the mixed method approach.

Descombe (2008) adequately summarises these characteristics as involving the use of:

- *quantitative and qualitative methods within the same research project;*
- *a research design that clearly specifies the sequencing and priority that is given to the quantitative and qualitative elements of data collection and analysis;*
- *an explicit account of the manner in which the quantitative and qualitative aspects of the research relate to each other, with heightened emphasis on the manner in which triangulation is used; and*
- *pragmatism as the philosophical underpinning for the research (Descombe, 2008).*

  Creswell and Plano Clark (2007) argue that the majority of research questions generally cross paradigmatic boundaries and cannot be adequately addressed using the positivist or interpretivist philosophies exclusively. In fields such as sociological and educational research, where evaluation and achievement scores are as important as the contributing factors, mixed methods research is increasingly used as a legitimate alternative to conventional mono-methods (Creswell & Plano Clark, 2007; Tashakkori & Teddlie, 2006).

In this study, the qualitative data generated from interviews and observations, were considered against quantitative data to increase the validity and trustworthiness of the research results. This use of a mixed-method approach assists in providing a clearer understanding of the data generated (Creswell, 2003).

3.3.2 Rationale for using a mixed method approach

There are many ways in which researchers use mixed methods research. Primarily, the incorporation of both qualitative and quantitative approaches is employed throughout the process of collecting and analysing the data, integrating the findings, and drawing inferences within a single study (Tashakkori & Cresswell, 2006). This process helps to improve the accuracy of data (Bryman, 2008) and helps to produce a more holistic picture of the phenomenon under investigation (Creswell & Plano Clark, 2007; Descombe, 2008). Bryman (2008) identifies a number of purposes for conducting mixed methods research. However, the most prominent reasons for a mixed method design points to issues of illustration of data, explanation of findings, offsetting weaknesses in one approach, providing stronger inferences, as well as strengthening triangulation. Triangulation is used to verify or support a single perspective of a particular social phenomenon (Jang, et al., 2008) and allows for greater validity through corroboration (Doyle, Brady & Byrne, 2009). In addition to increased validity, the use of qualitative and quantitative methods provides a clearer illustration of the data (Creswell, 2003). This is deemed useful when providing qualitative explanations to quantitative findings (or vice versa). For example, in this study, the final teacher interviews were conducted to clarify the quantitative results from the learners' science concepts. The study sought to examine the teaching of Natural sciences concepts to English second language speakers in selected primary schools. According to Creswell (2010), the mixed methods approach should be understood through the methodology and methods that it uses. Teddlie and Tashakkori (2009) assert that MMR is true integration of looking at phenomena from different perspectives of the quantitative and qualitative methods and providing an enriched understanding.

3.3.3 Challenges associated with the mixed method approach

A notable challenge when applying a mixed method design centres on how the researcher was able to adopt an impartial position of distance and neutrality (positivism) from the process and the participants, while promoting a subjective level of nearness and exchange when trying to understand of the participant's common realities (interpretivist) (Patton, 2010). Therefore, it is imperative that the researcher maintains and accepts the truth of their positions and that information claims cannot be mixed between what was resulting from quantitative data, with that derived from qualitative data (Creswell & Plano Clark, 2007). Additionally, researchers are advised to use different research methods in such a way that the consequential combination has complementary powers and not overlying weaknesses (Johnson & Turner, 2003).

This study adopted the mixed method research approach where the researcher combined the qualitative and quantitative methods. The reason for using mixed method is premised on the fact that it is a distinct research methodology that evolves as a way of" converging and triangulating different quantitative and qualitative data sources" (Creswell, 2009). Mixing of both quantitative and qualitative methods in the data collection process enables the researcher to solicit different views from different data sources that give adequate insights into the issues under study**.**

Qualitative and quantitative research methodologies have their own place in research depending on the approach the researcher wishes to follow, which type of research was used, and the type of knowledge the researcher wishes to produce (Jacobs, 2004). Jacobs further states that for many years, the quantitative research approach was regarded as the only "true" reflection of the truth, and qualitative research as an assault on the search for "truth". According to Denzin and Lincoln (2000) positivists allege that qualitative researchers write fiction, not science, and that qualitative researchers have no way of verifying their truth statement. They add that quantitative researchers thus saw their view of research as the only true search for meaning. The reason why some quantitative researchers are so negative about qualitative research is because quantitative researchers have a distinctive view about the nature of our knowledge regarding the physical and social word (Denzin & Lincoln, 2000). Qualitative researchers, however, question the view of quantitative researchers and often reject quantitative enterprise as epistemologically‟ flawed (Pring, 2000). The differences are also reflected in the respective language of each approach, and the way in which key ideas or concepts take on different logical characters. Some of these philosophical concepts link together in logically separate ways and take on slightly different meanings. According to Pring (2000) words such as 'objectivity and subjectivity', 'reality', 'truth' and 'verification', 'knowledge' and 'meaning', are interrelated and defined differently within the two paradigms. Punch (2004) adds that the type of study determines what type of data was used. It may be all quantitative, all qualitative or it may be a combination of both. He/she states further that the type of data the study consists of should determine primarily what approach should be followed. The researcher should first concentrate on what he/she is trying to find out, and not be limited by the rigid application of the research method (Punch, 2004).

3.3.4 Research techniques

According to Denzin and Lincoln (2000), the effort to describe and render an understandable world of subjective experience is the philosophic cornerstone of qualitative methodology. In quantitative methodology, the researcher tries to discover its "truths" or generalizable cause-effect relationship. When a researcher conducts a qualitative study for example, and makes use of statistical techniques, he/she is also using quantitative techniques. In such a case, the researcher is using the philosophy of one research methodology. Nyaba (2009) agrees that a researcher may use different approaches and techniques to give different dimensions of the research process. The researcher may use alternatives from the different dimensions in combination as appropriate to the study. This may include a set of research questions and may focus on specific approaches or techniques or may concentrate on either a qualitative or a quantitative strategy. The researcher may mix or vary the usage of these techniques. In this study, the researcher combined the qualitative and quantitative research methods, to come up with the mixed method. The following data collection instruments were used: questionnaire, semi structured interviews and observations. The questionnaire employed closed questions where the data gathered could be quantified, and open-ended questions where information consisted of respondents‟ interpretations of events (Nyaba, 2009). Semi-structured interviews are conducted by the researcher on senior phase NS HOD's and quantified. The researcher compiles observations during NS teaching and learning.

3.3.4.1 Quantitative research approach

Quantitative research, according to Van der Merwe (1996), quoted by Weinreich (2009) is a research approach aimed at testing theories, determining facts, demonstrating relationships between variables, and predicting outcomes. Quantitative research uses methods from the natural sciences that are designed to ensure objectivity, generalisability and reliability (Weinreich, 2009). The techniques used in quantitative research include random selection of research participants from the study population in an unbiased manner, the standardised questionnaire or intervention they receive, and statistical methods used to test predetermined hypotheses regarding the relationship between specific variables. Unlike in quantitative research where the researcher is regarded as a great research instrument due to active participation in the research process; in the qualitative paradigm, the researcher is considered as being external to the actual research, and results are expected to be replicable, no matter who conducts the research.

3.3.4.2 Qualitative research approach

Qualitative research, according to Weinreich (2009) is a research approach aimed at the development of theories and understanding. Denzin and Lincoln (2005) define qualitative research as a situated activity which locates the observer in the world. It involves an interpretive, naturalistic approach to the world, that is. qualitative researchers study phenomena in their natural settings, attempting to make sense of, or interpreting phenomena in terms of the meanings people bring to them. Qualitative research implies an emphasis on the qualities of entities and on processes and meanings that are not experimentally examined or measured (Denzin & Lincoln, 2005). In concert with Denzin and Lincoln (2005) and Patton (2010) defines qualitative research as an approach that uses a naturalistic approach which seeks to understand phenomena in context-specific settings, such as real-world settings, where the researcher does not attempt to manipulate the phenomena of interest. It is any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification, but instead the kind of research that produces findings derived at from real-world settings where the phenomena of interest unfold naturally. Weinreich (2009) indicates that the purpose of qualitative research is to provide the researcher with the perspective of target audience members through immersion in a culture or situation and direct interaction with the people under study. This implies that in the qualitative paradigm, the researcher becomes an instrument of data collection, and results may differ greatly depending on who conducts the research.

The objective of qualitative research is to promote better self-understanding and increase insight into the human condition. Unlike quantitative research which has, as its objective, collecting facts about human behaviour that lead to verification and extension of theories, qualitative research emphasises the improved understanding of human behaviour and experience. Qualitative methods include direct observation, document analysis and overview, participant observation, and open-ended unstructured interviewing. These methods are designed to help researchers to understand the meanings people assign to social phenomena and to elucidate the mental processes underlying behavior. Denzin and Lincoln (2005) characterise qualitative inquiry as research approach that is generally conducted in natural settings, utilising the researcher as the chief tool in both data gathering and analysis. The benefits of qualitative inquiry are embedded in its emphasis on thick description, that is. obtaining real, rich, deep data which illuminates everyday patterns of action and meaning from the perspective of those being studied. This view emphasises the importance of the voice of the researched and gaining first-hand information regarding the lived experiences of the researched on a subject. It tends to focus on social processes, where the established relationship between the researcher and the respondents is valued, rather than primarily the outcomes. Qualitative inquiry involves employing multiple data gathering methods, especially participant interviews, and uses an inductive approach to data analysis, extracting its concepts from the mass of certain detail which constitutes the data base. The strength of qualitative approaches, according to Weinreich (2009), is that, they generate rich, detailed data that provide the participants' "…perspective intact and provide a context for the phenomena being studied." A disadvantage of data collection in the qualitative approach is that it may be labour-intensive and time consuming.

Table 3.1: Quantitative versus qualitative research: key points in the research debate (adapted from Neill, 2007)

Quantitative research	Qualitative research
The aim is to classify features, count them, and construct statistical models to explain what is observed.	The aim is a complete, detailed description of phenomenon.

The researcher knows clearly in advance what s/he is looking for.	The researcher may only know roughly in advance what s/he is looking for.
Recommended during latter phase of research projects.	Recommended during earlier phase of research projects.
All aspects of the study are carefully designed before data is collected.	The design emerges as the study unfolds.
The researcher uses tools such as questionnaires or equipment to collect numerical data.	The research is the data gathering tool.
Data are in the form of numbers and statistics.	Data are in the form of words, pictures or objects.
Objective – seeks precise measurement and analysis of target concepts e.g. uses surveys, questionnaires etc.	Subjective – individuals' interpretation of events is important e.g. uses participant observation, in-depth interviews etc.
Quantitative data are more efficient to test hypotheses but may miss contextual detail.	Qualitative data are richer, time-consuming and less able to be generalized
The researcher tends to remain objectively separated from the subject matter.	The researcher tends to become subjectively immersed in the subject matter.

3.4 RESEARCH DESIGN

Research design used in the study was the concurrent triangulation, meaning that qualitative and quantitative data were collected during the same phase of the research process and then merged into an overall interpretation because the researcher wanted to examine the strategies employed by teachers in teaching Natural sciences concepts to English second language speakers. The main purpose was to understand or develop an in-depth understanding of the problem by obtaining different but complementary data that would validate the findings of the study (Creswell& Plano- Clark, 2011). The intent was also to bring together differing strengths and non-overlapping weakness of quantitative methods (large sample size, trends and generalizations) with those of qualitative methods (small sample, details, and in-depth) (Creswell, 2006). These attributes of the convergent research design assisted the researcher in developing a more complete understanding of the teacher practices who taught Natural sciences concepts to English second language speakers.

3.4.2 Types of mixed method research designs

According to Clark and Linder (2006:376), mixed methods paradigm consists of four major types of mixed methods designs. They are concurrent triangulation, embedded, sequential explanatory, and exploratory designs. The designs are employed to address various research objectives and the timing of qualitative and quantitative methods employed in the study differentiates them. The authors also explicate how the qualitative and quantitative methods are integrated in a single study.

3.4.2.1 The concurrent/ triangulation design

The concurrent/ triangulation design is the most common approach in mixed method research. It helps the researcher understand the research problem and involves methods of collecting and analysing quantitative and qualitative data concurrently. In this design, two or more data sets are combined to understand better the research problem that is under the study. Ridenour and Newman (2008) note that triangulation is the combination of several data resources or collection strategies in the same design to enhance validity. Concurrent design refers to the time order decision in which data are mixed. This means that, in the process of mixing data, the emphasis can be given to a design. The emphasis can be given equal status for both qualitative and quantitative designs; or higher status to either the qualitative or quantitative one.

The concurrent mixed method of data collecting strategies can be employed to validate one form of data with the other form, to transform the data comparison, or to address different types of questions. In this sense, the collected data can be mixed and triangulated while processing the data for interpretation. Triangulation is defined as the mixing of data or methods so that diverse viewpoints cast light upon a research problem. For example, mixing the use of survey data with interviews is an exemplary form of triangulation as it refers to the mixing of methods. It seeks convergence and corroboration of results from different methods and designs studying the same phenomenon. Thus, it is a way of looking at the data from two or more angels to find out the results of data.

3.4.2.2 Embedded research design

The embedded research design focuses on the collection of both quantitative and qualitative data used to approach the research problem in experiment and intervention of the problems. It concentrates on the processes of collection and analysis of qualitative and quantitative data. The data that are collected before, during and after trials are analysed and then interpreted. The embedded design consists of embedding one method (quantitative or qualitative) within a large study guided by the other method (quantitative or qualitative), having a secondary method to address different questions and using the secondary method to enhance the implementation and/or interpretation of the primary method (Clark & Linder, 2006).

3.4.2.3 Sequential explanatory design

The sequential explanatory design is a form of mixed methods research which involves implementing the methods in two distinct phases; starting with quantitative data collection and analysis, connecting from the quantitative results of a qualitative phase, and using the qualitative data collection and results to follow up or explain the initial quantitative results (Clark & Linder, 2006). It is also used when the topic needs to be explored qualitatively before it can be measured or tested quantitatively, and before results of the findings are finally interpreted. The researcher adopted triangulation or concurrent mixed methods design in this study. The purpose of employing this triangulation or simultaneous mixed methods design was to investigate and understand the research question or problem that is under study. This design enabled the researcher to collect qualitative and quantitative data in order to understand more rigorously, the research questions. As pointed out by Hesse- Biber (2010), triangulation/concurrent method design enables the researcher to gain the more rigorous understanding of quantitative results by integrating qualitative findings to triangulate the research findings and to explore divergent or disparate finding. Therefore, in this study, the researcher used both quantitative and qualitative data. Then the quantitative data are combined with the qualitative data for their validation. To collect the data for this study, the researcher employed a survey questionnaire, interview and observation to collect data from various resources.

3.4.2.4 Advantages of using mixed method approach

The advantages of using a mixed method approach for this research is summarised by Creswell and Plano Clarke (2011). An apparent weakness of quantitative research is that it is often perceived and seen to be weak in understanding the context or setting in which people talk and the voices of respondents are accordingly not directly (verbally) heard. On the other hand, qualitative research is seen as deficient, because of the personal interpretations and the involvement of the researcher that may lead to bias. Mixed method research provides more comprehensive evidence for studying a research problem than either qualitative or quantitative research alone. Mixed method research helps to answer questions that cannot otherwise be answered (Creswell & Plano Clarke, 2011). Mixed method research is "practical", as the researcher is free to use relevant methods, skills and thinking to address a research problem. Mixed method research enables the use of an all-encompassing paradigm, such as pragmatism. It is imperative for the researcher to decide on the specific mixed methods design that best addresses the research problem. Hence, the specific mixed methods for this research are elaborated upon.

3.4.2.5 The strategical method

This study sought to investigate the teaching of natural sciences concepts to English second language learners in primary schools. The use of the mixed methods approach allowed the researcher to seek clarity and deeper understandings by finding convergence and corroboration of the results from a variety of data sources. For example, the quantitative analysis of the learner's experience and science teaching was supplemented by descriptions of learner activities in the classrooms and the teachers' perspectives on the impact of the strategy. Both qualitative and quantitative methods were utilised in order to gain the most accurate insight into the teaching and learning of NS concepts and the teachers' perceptions of its usefulness. During the data collection and analysis process, quantitative methods were used exclusively for the learners' participation, and the phase HoDS interviews and portfolios was analysed using qualitative methods. A mixed method approach was used for the classroom observations and the learners' science textbooks. Throughout the analysis and interpretation process, data were also combined and compared to allow accurate representation of the findings. For example, quantitative information from classroom observations, science textbooks and the learners' activities were used to support and triangulate the qualitative information gathered from the interviews. As this study sought to investigate teaching of NS concepts which contribute to improving scientific literacy through the professional development of science teachers and the implementation of a new model, both qualitative and quantitative approaches were equally appreciated varied perspectives to this study. The methods were conducted concurrently, and the mixing of the qualitative and quantitative methods occurred during the interpretation of the data. For example, the quantitative analysis of the Raven's Progressive Standard Matrices data was supplemented by rich descriptions of learner activities in the classroom. Additionally, the method used for learning, classroom observations and learners' science textbook reflect Creswell and Plano Clark's (2007) notion of the embedded design's correlational model, whereby qualitative data are rooted within a quantitative design to help explain the outcomes. The classroom observation and the science notebook instruments utilised a quantitative scale to measure performance and additional space on the instrument provided for the researcher's qualitative descriptions and explanations, while interviews explored the participants' understandings of the process in depth.

In addition to the context of this study, was to investigate the nature and the extent of how Grade 7 Natural sciences teachers deal with the challenge of interpreting science concepts using mother tongue instruction. The purpose of this research was to investigate new or little-known phenomena and to discover themes from participants' meanings (McMillan & Schumacher, 2001) on the difficulties faced by teachers in the implementation of mother tongue instruction in a Grade 7 Natural sciences class.

3.5 POPULATION

A population is the larger group about which a generalisation is made and is a group of individuals who have the same characteristic (Creswell, 2008). Johnson and Christensen (2008) assert that a population is a large group to which a researcher wants to generalise the sample results. A population is the total group that the researcher is interested in learning more about (Johnson & Christensen, 2004). McMillan and Schumacher (2006) view a population as a group of individuals with common elements, objects, or events that conform to specific criteria and to which researchers intend to generalise the results of the research. Creswell (2014) describes population as that group which the researcher is interested in gaining information about and drawing conclusions from. Best and Heugh (2005) define a population as any group of individuals that has one or more characteristics in common, and that are of interest to the researcher. For this study, there are several target populations that were considered, comprising all senior primary schools, all grade 7 Natural sciences teachers, and all grade 7 natural sciences learners in the East London district. East London district has 142 senior primary schools categorised as public schools. Of the 142 East London primary schools, 21 were farm schools, 25 rural, 22 urban and 53 are township schools. There were 206 natural sciences teachers (104 males and 102 females) and 7297 (3556 boys and 3741girls) Natural sciences learners at the East London District, with 989, farm school learners, 1189 village learners, 2524 urban learners, and 2652 township learners. The researcher conveniently chose the township schools because most children who attend township schools are learners from families where they are not exposed to English as a medium of communication. The population of Natural sciences teachers was 64(38 females and 26 males). The total number of Grade 7 NS learners was 2652 (1434 girls and 1218 boys). A research population does not always refer to people, but any collective phenomenon selected to form the focus of research, whether it is people, settings, artefacts, events, behaviours or social processes (Babbie,2010; Goddard & Melville, 2001).

3.5.2.7 Sample and Sampling Techniques used for the Current Study

Kumar (2011), defines sampling as the process of selecting a sample from a bigger group population as the basis for estimating a prediction of the prevalence of an unknown information or situation as an outcome regarding the bigger group. This study used the mixed method approach, therefore, sampling techniques for qualitative side and for quantitative side was utilised. This study employed a two-stage random sampling to cater for both probability and purposive sampling, using the concurrent mixed methods sampling strategy (Teddlie & Yu, 2007). The concurrent mixed methods sampling involved the selection of units of analysis for a study through the simultaneous use of both probability and purposive sampling. In this case, one type of sampling procedure did not set the stage for another. Instead, both probability and purposive sampling procedures are used at the same time. For the quantitative dimension, the researcher considered 50 Natural sciences teachers teaching in township schools who were randomly selected from the population of 64 NS teachers from township schools. The researcher employed simple random sampling for learners from a total population of 2652 (1434 girls and 1218 boys) Natural Sciences learners. Therefore, the sample size for the learners was 253 (140 girls and 113 boys). For the qualitative dimension, the researcher used purposive sampling to select 10 HODs from 10 schools (their proximity to the researcher's work place as seen as a positive in terms of convenience). In addition, these schools were in the same circuit and the researcher had established good professional relationships with those schools). In addition, 40 learners from five schools (8 learners per school) participated in focus group discussions. The sample for HODs and learners was purposive in the sense that the researcher targeted information rich participants who were involved in the teaching and learning of NS at Grade 7 level.

3.5.2 Sampling

Mkandawire (2009) defines sampling as a process in research whereby a small group that forms part of a larger group is identified. The small group is called a sample from which information is obtained. Due to time and cost constraints, it is seldom possible to include the entire population in a study (Maree, 2010). Sampling involves the selection of a workable number of participants from the research population under investigation (Babbie, 2010). In a sample, the participants must be a representative of the population to be studied. According to Johnson and Christensen (2004) purposive sampling is a commonly used procedure for focus group interviews. It is an approach that is frequently used as a method of extending knowledge by deliberately selecting sample participants who are known to be rich sources of data. Another advantage of using purposive sampling for interviews, according to Mastalgia, Toye and Kristjanson, (2003) is that individuals who have experienced the phenomenon of interest are invited to participate, contributing a wide range of domain descriptors and construct dimensions. It is important to note, as Jamieson and Wereiams (2003) argue, that it is not usually the aim of a focus group study to achieve consensus on issues, but to identify honest perceptions that may differ between participants thus the homogenous characteristics desired for each group should be based on a desire to promote open discussion. Ekblad, Marttila and Emilson, (2000) support this view by indicating that "*a sufficient measure of heterogeneity among the participants" other characteristics is needed to encourage dynamic group interaction and allow contrasting opinions".* There are two techniques of sampling, viz. probability and non-probability sampling (Maree, 2010 and Jackson, 2008).

3.5. 2.1 Probability Sampling

Probability sampling refers to the method of selecting a workable number of participants from a population whereby the exact number and location of the population elements is known to, and reachable by the researcher (Babbie, 2010). The main aim of probability sampling is to select a set of characteristics in a way that portrays the actual parameters that exist within the overall population represented. Probability sampling makes use of a random selection process. With this, each member of a population has an equal chance of being selected to be part of the sample (Maree, 2010). With probability sampling, concerns are more on statistical accuracy.

3.5.2.2 Non-Probability Sampling

Non-probability sampling refers to the method of selecting participants from a population whereby the number and location of the population elements is not known to the researcher (Babbie, 2010). This is often used in instances when the probability samples used in large-scale social surveys are not appropriate. In contrast to probability sampling, individual members of a population do not have an equal likelihood of being selected into the sample, random sampling methods are not used in non-probability sampling (Maree, 2010). Depending on the type of population and the particular details of an investigation, the researcher may choose any one of the four types of non-probability sampling techniques. They are; convenience, quota, snowball and purposive sampling.

3.5.2.4 Convenience sampling

Convenience sampling refers to a non-probability method of selecting participants from a population based on their availability and convenience to the researcher (Blanche *et al*., 2006). The type of sample produced from convenience sampling is not representative enough of the entire population. For instance, if an interviewer conducted a survey in a shopping mall early in the morning on a given day, the people interviewed would be limited to a given time. In this instance, the result of the interviews would not represent the wider views of the people in that area. Therefore, a researcher cannot scientifically make generalisations about the total population. Since this study deals with real life problems in the national education systems, being able to generalise was important in this study.

3.5.2.5 Quota Sampling

Quota sampling is a non-probability method of selecting participants from a population with varying characteristics that can be divided into sub-groups (Jackson, 2008). From these sub-groups, subjects or units to be researched are selected, based on the characteristics as determined by the researcher. Quota sampling, however, is statistical in nature and is mostly appropriate in research projects where statistical representation is most desired (Babbie, 2010). The focus of this study, however, is in-depth understanding of the problem issues of teaching of NS concept to grade 7 English second language learners in schools and in the curricula, rather than statistical proportions. Hence, a more appropriate method of sampling was required.

3.5.2.6 Snowball Sampling

Snowballing is a method of finding participants from the population whose identities and location is not known and cannot be easily traced (Babbie, 2010). For example, when sampling homeless individuals, migrant workers, undocumented immigrants, the researcher may need referrals by one member to assist him locate other participants (Maree, 2010). Due to the fact that samples gained from this procedure are generally questionable, it is mainly used for exploration purposes. This research is not an exploration, and therefore a snowball sampling method is not appropriate.

3.6 DATA COLLECTION INSTRUMENTS

Collection of data is necessary to obtain information that provides answers to important questions (Johanston & Christensen, 2004). Data were collected by means of semi structured interviews, questionnaires and focus group to learners. This section provides a description and rationale of the instruments used in this study. The instruments were used in the data collection procedures to investigate the teaching of NS concepts to English second language learners.

3.6.1 Instruments

In this section, the instruments used to gather data in this study are discussed: Quantitative data collection instruments that were used in this study included semi-structured questionnaires for teachers and for learners. Semi structured questionnaires are usually viewed as a more objective research tool that can produce generalisable results and evidence of patterns amongst large populations and samples (Harris & Brown, 2010; Kendall, 2008). The semi-structured questionnaire was suitable in this study to cater for the large samples of both teachers and learners. In addition, it provided participants a chance to freely give their responses without the interference of the researcher. Semi structured questionnaires for learners were utilised to create a better understanding of Science and Scientific Inquiry instrument. It was adopted and renamed as the Learners' Understanding of Science and Scientific Inquiry (LUSSI) instrument. The researcher developed a questionnaire based on the variable themes for the quantitative data collection. The qualitative side of the study used individual interviews with Natural sciences HODs, one per school out of 10 schools. Focus group interviews were also held with learners just 10 per school in 5 schools, and classroom observations in ten schools.

3.6.2 Questionnaires

Semi-structured questionnaire was suitable in this study to cater for the large samples of both teachers and learners**.** Johnson & Christensen (2008) describe a questionnaire as a self-report data collection instrument that each research participant completes as part of a research study. McMillan & Schumacher (2010) assert that it is the most popular technique for obtaining data from participants because it is relatively reasonable. In this study, it is assumed to be convenient and efficient for obtaining data from a large sample of learners and teachers of science in different schools. The questionnaire had other numerous advantages, which is the reason why it was considered an appropriate research tool for this research. It was simple to administer and takes less time would in the already overloaded school curriculum of the teachers and learners. It may be used along with other data collection methods like interviews. Also, it was imperative to administer properly designed, authentic and valid questionnaires so that the data obtained is more accurate and useful (Gay, Mills, & Airasian, 2006 and Opie, 2010).

According to Rule and John (2011) questionnaire is good for saving time and money, and when you want to collect data from people simultaneously. However, the researcher might lose opportunity to probe information further. The researcher chose to use questionnaires as another data collection instrument because questionnaires could be distributed to many respondents simultaneously; therefore, large sample of population can be covered, and respondents could complete questionnaires in their own time, giving respondents more time to consider answer before final response in a more relaxed atmosphere. Questionnaires allowed respondents to respond exactly to the same questions because standards instructions are given to the respondents. The data provided by questionnaires could be more easily analysed and interpreted than data obtained from verbal responses. It facilitates the collection of vast amounts of data with minimal effort. As research instruments, questionnaires could be used time and time again to measure differences between groups of people. They were thus, reliable data gathering tools. The person administering the instrument has the opportunity to establish rapport, explain the purpose of the study and elaborate on the meaning of items that may not be clear. Well- designed questionnaires could allow relationships between data to be identified. They were particularly useful for showing relationships with data that are easily quantifiable. However, the questionnaire was also disadvantageous because the researcher needed to be attentive while conducting research. If the researcher forgets to ask a question, s/he cannot usually go back to respondents, especially if they are anonymous. When distributing questionnaires, it was sometimes difficult to obtain a sufficient number of responses. Those who had an interest in the subject might be more likely to respond, skewing the sample as they might ignore certain questions. Questionnaires may appear impersonal and respondents might misunderstand questions because of poor design and ambiguous language.

Questionnaires often provide low response (return rates), are time-consuming in follow-up and data entry. Ease of production and distribution can result in the collection of more data than can be effectively used. Lack of adequate time to complete the instrument might result in the return of superficial data. Absence of personal contact (if the questionnaire is mailed) may mean that response rates suffer, necessitating the expense of follow-up letters, telephone calls and other means of chasing the participant.

3.6.3 Interviews

Interviews were the most common form of data collection. Creswell (2012) defines interviews as a “conversation with a purpose” where the interviewer elicits information from the participant. This type of information generally comprises participants’ description of opinions, feelings, experiences, meanings and intentions during the interview. In this study, interviews were conducted with Natural sciences Grade 7 learners and HoDs as already mentioned in the sampling. According to Fischler (2005) it is possible in an interview, to get a deep insight of the respondents’ system of beliefs and knowledge. One of the aims of an interview is to understand the participant’s views.

There are many different types of interviews, namely; problem focused interview, group discussions, narrative interview, participatory interview and “one-on-one interview” (Creswell, 2012). In the group discussions, information concerning views, opinions and beliefs is shared by the group of people participating in that study (Fischler, 2005). According to Henning, Van Rensburg and Smit (2004), interviews are used if one is looking for information based on emotions, feelings and experiences, potentially sensitive issues, and information based on insider experience and privileged insights. In this study, the interview method was used to expand the data collected by the use of the questionnaire method. After administering a questionnaire to the learners, it was necessary to know their views, opinions and beliefs concerning their choices. The HoDs were also interviewed in order to determine whether their explanations during the teaching and supervision process influenced the learners’ understanding of the NS concepts meaning of the everyday words.

The interview can be classified as structured or semi-structured (Oyoo, 2009). This depends on the types of questions the interviewer poses to the respondent. In a structured interview, the researcher takes the lead with some guidelines, where the set of questions used is difficult with no permission to divert (McMillan & Schumacher, 2010; Creswell, 2012). However, a semi-structured interview is open, allows the researcher to bring in new ideas during the interview depending on the interviewee’s responses aims and objectives of the study. The researcher used focus group learner’s interview schedule and HoDs interview schedule as a guideline for the interviews in this study.

3.6.3.2 Advantages of using Structured Interviews for Data Collection

Structured interviews are useful for data collection because the responses highlight aspects that could not be observed directly. An inner perspective to outward behaviour was added. Interviews allowed for probing, thus increasing accuracy of response. They also ensure the correct or intended interpretation of questions. Respondents could also raise concerns. Interviews enable modification to lines of inquiry. They also allowed respondents to describe what was meaningful using their own words, and the researcher was able to observe interviewees' body language.

3.6.3.3 Disadvantages of Using Structured Interviews for Data Collection

The success of interviews for data collection depended on the researcher's communication skill. Using interviews was time-consuming and requires considerable experience without which the researcher might fail to get the required data. Using interviews was also more intrusive and respondents might say more than what they intended to say and later regret. The present researcher chose interviews as one of the ways of gathering information because interviews yield a great deal of useful information. The questions that were asked by the researcher related to facts, feelings, and motives; present and past behaviours. Interviews also assisted the researcher to obtain information regarding standards for behaviour, meaning what the interviewees thought should be done in certain situations as well as the conscious reasons for actions.

3.6.4 Focus Group in this study

Focus groups are structured small group interviews, and according to Taylor-Powell (2002), they are "focused" in two ways. First, the persons being interviewed are similar in some way, and second; the purpose of the interview is to gather information about a particular topic guided by a set of focused questions. Parker (2006), discusses the difference between a focus group and a group interview, which aided the research in concluding that the session was focus group although questions were also asked. They highlighted the role of the researcher throughout the method and suggest that within a focus group the researcher does not take centre stage but facilitates the discussion often between the participants rather than one to one discussion between researcher and individual. However, the focus group participants were prompted to explain their answers further. The qualitative data for this study was obtained through focus group interviews with learners. The primary aim of a focus group is to describe and understand meanings and interpretations of a select group of people to gain an understanding of a specific issue from the perspective of the participants of the group (Liamputtong, 2011). Gubrium and Holstein (2003), add that a focus group interview is a group discussion designed to explore topics where little information is known, or where respondents' views about a topic need to be obtained. Parker (2006), further state that it involves the simultaneous use of multiple respondents to generate data, and the 'focused' (on an external stimulus) and relatively staged (by a moderator) nature of the focus group method separates it from other types of group interviewing strategies. Focus group interviews in an informal setting allow participants to discuss issues in a relaxed and comfortable environment (Millar, 2006). In the school setting, focus group interviews provide a safety net for learners since they are more relaxed in the company of fellow learners, and are freely able to discuss a topic in detail (Gubrium & Holstein, 2003). The focus group size can range from four to twelve (Krueger and Casey, 2000). Liamputtong (2011) suggests that smaller groups are preferable since they allow participants to speak freely and to explore issues thoroughly, resulting in rich and relevant information. In this study, each of the focus groups comprised four to five learners. The researcher was able to explore issues thoroughly with a small group. Furthermore, some school principals were not in favour of releasing too many learners from their classes during class time.

3.6.5 Classroom observation

Classroom observation was a particularly suitable technique for the collection of data because through its use, the researcher was able to observe the research subjects' behavior directly, as well as making face to face interaction with them in a natural setting.

These observations were deemed necessary in order to get the "feel" of the research subjects' learning processes and skills in Science. Consequently, the researcher was able to obtain valuable data on activities and processes which the subjects were engaged in but were not consciously aware of**.** Observation is a way for the researcher to see and hear what is occurring naturally in the research site. By observing naturally occurring behaviour, the researcher hopes to obtain a rich understanding of the phenomenon being studied" (McMillan& Schumacher, 2014).

The focus was on whether, and how, learning support was provided during instruction time. Randomly selected classes were observed as they followed their normal timetable. Observations can be overt or covert. In covert observation, the observer is not known by the people he/she observes, and he/she does it in secrecy while in overt observation, the observer is known by the people he/she observes (Patton 2010). In this study, the researcher used participant observation/overt where he basically observed lessons in progress. Thus, he immersed himself into an actual situation in an effort to draw out and document the subjects' reactions. This enabled him to become part of the group and interact with them. It created an atmosphere in which he interacted freely with subjects in their class activities, thereby developing mutual trust. The researcher used the observation technique as a supplementary method/data collection technique to the interview method. The researcher used this method purposely to establish facts from the learners and the classroom educators regarding the subject under study. In the process of observation, the researcher used structured form of observation, whereby the researcher focused on the same features in the lessons that were observed. In classroom observation, the researcher focused on teaching and learning of NS concepts to English second language learners and how the use of English as the language of learning and teaching (LoLT) influenced learners' abilities to learn Science concepts.

The following classroom aspects were observed:

I. The classroom environment: school buildings in general, number of learners, resources for learners to establish their effect on the teaching and learning of Science.

II. Language used for general communication in the classroom.

III. Language used by teachers when giving instructions, asking questions and explaining NS concepts.

IV. Laboratory facilities: to establish their contribution in the learning of Science.

V. Libraries: to look at their impact language-wise on the part of learners.

VI. Classroom interactions that is. educators' English competence, learners' English proficiency.

VII. Educators' teaching style: educator's pace, educator's approach, link with prior knowledge.

VIII. Language used by learners to answer questions and ask questions during the lessons

Table 3.2 shows the alignment of research questions, research objectives, unit of analysis, research instruments and data nature.

Table 3.2: Alignment of research items

Research Question	Research Objectives	Unit of analysis	Research instrument	Data nature
How do teachers link the teaching of Natural sciences concepts to learners' prior knowledge?	Assess how teachers link the teaching of Natural sciences concepts to learners' prior knowledge	Teachers HoDs learners	Questionnaire Interviews Focus group	Qualitative Quantitative method
What learner-centred strategies are utilised in the teaching and learning of Natural Science concepts?	Establish how learner- centred strategies are utilised in the teaching and learning of Natural sciences concepts.	Teachers And HoDs	Interviews questionnaire	Qualitative Quantitative method
How do strategies employed by teachers assist learners in learning Natural Science concepts?	Ascertain how strategies employed by teachers assist learners in learning	HoDs teachers Learners	Interviews Questionnaire observations	Qualitative and quantitative method
	Natural Science concepts.			

What challenges do teachers and learners encounter in the teaching and learning of science concepts?	Establish challenges teachers and learners encounter in the teaching and learning of science concepts	Teachers learners	Questionnaire and observations	quantitative
What are the implications for science education?	Assess the implications for science education.	HoDs Teachers and learners	interviews questionnaires observations	Qualitative and quantitative method

3.7 Validity and Reliability

According to Setati (2011) validity and reliability are key concepts in any form of enquiry. For a research study to be accurate, its findings must be reliable and valid. Different writers address the issue of validity and reliability differently. Validity and reliability were utilised as criteria for judging the quality of the research design. There are different forms of validity, which this study was employed to ascertain its accuracy, meaningfulness and credibility (Leedy & Ormrod, 2013). These forms include construct, content, and concurrent validity. Research instruments were pilot tested and expert opinion sought to increase the instruments' validity. This study ensured reliability of the data collection instruments by pilot testing the instruments and calculating Cronbach's alpha among other measures. In this study, the questionnaire and interviews were regarded as valid and these instruments elicited for accurate information. They provide a real measure of examining the teaching of Natural sciences concepts to English second language speakers in selected primary schools. For the purposes of this study, a pilot study was conducted, and the Cronbach alpha coefficient (Cronbach alpha) were also be used to measure the reliability of the measurement instrument (in this case the questionnaire).

3.7.1.1 Pilot testing

Wilson (2009) define the pilot study as a small study conducted prior to a larger piece of research to determine whether the methodology, sampling, instruments and analysis are adequate and appropriate. And De Vos (2002), defines a pilot study as the process whereby the research design for a prospective survey is tested. Mouton (2001) concurs that the pilot test in qualitative research allows the researcher to make use of the actual qualitative interviews. According to Wilkinson (2005), the researcher can begin to identify and correct imperfections by piloting or testing a questionnaire with a select few people in order to establish their clarity. Piloting further assists in eliminating ambiguous questions, as well as in generating useful feedback on the structure and flow of the intended interview. De Vos et al. (2011) detects pilot study as possible flaws in the measurement process (such as ambiguous instructions, and inadequate time limits). In such a pilot study, the actual questions are put to the participants and they are then asked to indicate how they have interpreted the formulated questions. An opportunity is accorded to researchers and assistants to notice non-verbal behaviour (on the part of participants) that may possibly signify discomfort or wording of the questions (Westwood, 2004).

3.7.1.2 The Cronbach's alpha

Internal consistency refers to the degree of correlation between the various items of a measuring construct (Sekaran & Bougie, 2010). The Cronbach alpha coefficient is widely used as a reliable procedure to indicate how well various items are positively correlated to one another (Sekaran & Bougie, 2010). The Cronbach alpha is based on the inter-item correlations. If the items are strongly correlated with each other, their internal consistency is high and the alpha coefficient was close to one. However, if the items are poorly formulated and do not correlate strongly, the alpha coefficient was close to zero.

Guidelines for the interpretation of Cronbach's alpha coefficient have been suggested and the following seem widely and generally accepted by researchers:

- 0.90-high reliability;
- 0.80-moderate reliability; and
- 0.70-low reliability

For this study, a statistical method was used to calculate the Cronbach alpha coefficient, to assess the internal consistency of the various question items of the questionnaire (S; as Institute Inc, 2013). The Cronbach alpha coefficient was also calculated for each group of items in order to illustrate the internal consistency of each subsection. It also served another purpose in indicating the level of measuring the same construct validity. Apart from the importance of the concept reliability in the context of measurement, validity is widely considered as important in the context of measurement to ensure the success of any study.

3.7.2 VALIDITY

Validity measures truth. In other words, it measures the extent to which data and findings present an accurate account of the events they claim to be describing (Silverman, 2000). According to Maxwell (2005), "validity is generally acknowledged to be a *key* issue in research design". Validity stands out as a critical component in answering questions like: *How were readers know that the conclusions are valid? Why should they believe the results? What if the researcher is wrong?* Therefore, validity is the degree to which a choice of a research method investigates what it is intended to investigate. Validity, in other words refers to the truthfulness and trustworthiness of findings. Validity is a key concept in any form of enquiry (Ralenala, 2003). Validity, furthermore, is concerned with whether the researcher is actually observing and measuring what the researcher thinks. One way to assess how valid an instrument is, is by comparing its results with other sources of data (De Vos, 2002; Du Plooy, 2002; Ralenala (2003) asserts that "individuals must be interviewed in sufficient detail for the results to be taken as true, correct, complete and believable" in order to establish validity. Validity, in this study, was catered for by the use of multiple methods of data collection, namely; the use of the quantitative and qualitative approaches and a comprehensive document analysis to back the study's thesis.

Internal validity: is crucial to experimental research designs; and it might be obtained by using at least two groups that are equal in respect of both the dependent variable and all nuisance variables. Cozby (2007) believes that the internal validity of a research study is the extent to which its design allows the researcher to draw accurate conclusions about cause-and-effect relationships. To ensure the internal validity of research, the researcher needs to attempt to eliminate any other possible explanations for the results observed (Devlin, 2006; Cozby, 2007).

External validity: if a study lacks external validity, then one is not confident that the findings can be applied beyond the narrow confines of the study. One especially common threat to external validity is the lack of random selection. When the sample does not reasonably represent the population, external validity is lacking (Guba and Lincoln, 2011) Shadish, Cook and Campbell (2002) suggest four areas of doubt concerning the ability to generalise findings:

- The researcher's inability to conceptualise performance indicators, so that other researchers can replicate the experiment;
- The researcher's inability to ensure that the experimental and control groups are representative of larger populations;
- The researcher's inability to be confident that the operationalised variables in the experimental setting can be replicated in real-life situations; and
- The researcher's inability to be certain that internal validity variables such as history, maturation, pre-test sensation, test reliability and selection (Stone, 2007) would not detrimentally affect external validity.

Measurement validities: Neuman (2011) describes measurement validity "as how well an empirical indicator and the conceptual definition of the construct that the indicator is supposed to measure fit together". Although there are many types of validity, authors are generally in agreement that there are a few common techniques used to assess the validity of a measuring instrument. Regarding content validity, Kumur (2011) distinguishes three types of content validity, namely face validity, sample validity and factorial validity. Face validity, according to Lankford and Volkmann (2009), refers to the relationship (similarities/correlation) between the researcher's description of concepts and description of the categories measured. In the light of the purpose of the current research, face validity determines if a questionnaire, after a superficial (on the surface/on the face of it) assessment, looks valid at first glance (the face of it) for a respondent (person) who has to complete the questionnaire. That face validity does not refer to what items of a questionnaire really measure, but rather what the researcher wants it to measure at first glance. In other words, each question or item on the measurement instrument should have a logical link with an objective. Broadly, the establishment of the referred link, is called face validity (Kumur, 2011).

Sample validity (logical) of a measuring instrument for instance, a questionnaire, is grounded on a representative sample of the content subjacent to the concept about which information is obtained from. In this regard, Lankford and Volkmann (2009) notes that

"content validity is the degree to which the total variance of the sample (the actual questionnaire) is related to the variance in the total possible population of tasks or items". Factorial validity of a measuring instrument (questionnaire) refers to the loading of the questionnaire with a general factor – in other words, the relation (correlation) which exists between the questionnaire and a common factor, as measured by means of the questionnaire (Kumar, 2011 and Lankford & Volkmann, 2009). Devlin (2006) implicitly purports that there is a relation (correlation) between the questionnaire and a common factor which is measured by means of the questionnaire. Two other forms of validity are construct validity and criterion validity. It has been the purpose of the study to determine the perceptions of respondents on the importance of science management abilities in developing management programme for educator training, which would enable science teachers to teach science in accordance with the diverse needs of South African schools. Concept validity accepts relation to expectations supported by concept relevant to the theory. In an endeavor to ensure construct validity for the current study, the questionnaire items were developed in position with the theoretical foundations concerning school management (Devlin, 2006). Face validity was optimised by the conduct of a pilot test to verify the relevance and representativeness of the various items to the intended setting (Kumar, 2011). Criterion validity is seen as the ability of a measure to link with other standard measures of similar constructs or established measures. Given the fact that no other standard measure of similar constructs or established criteria was available, criterion validity was therefore not established. Subsequently, it is in line with the research design adopted for this research (Kumar, 2011). Internal validity was ensured by means of a substantial theoretical framework, initial qualitative data, and an adapted existing questionnaire.

3.7.2 Reliability

Reliability is viewed by McMillan and Schumacher (2006) as an attempt to establish the consistency and accuracy of a tool by yielding similar results even if it could be administered to another set of samples with similar characteristics. Reliability is therefore, the degree to which research findings reflect consistency when repeated on several occasions in the same social setting. It is the consistency with which a measuring instrument yields a certain result when the entity measured has not changed. The aim thereof is to minimise errors and biases (Bryman, 2008; Leedy & Ormrod, 2013). Reliability refers to whether the research instruments are consistent (Silverman, 2000). A central question in order to secure the reliability of a study is whether a research instrument would measure the same when used in other occasions.

3.8 TRUSTWORTHINESS AND CREDIBILITY

Trustworthiness refers to the quality of an investigation and its findings that makes it noteworthy to its audience (Schwardt, 2007). In order to ensure trustworthiness of the data collected, the following measures were taken into consideration-

1) Credibility,
2) Dependability, and
3) Confirm-ability

3.8. 1 Credibility

According to Gardner (2009), credibility refers to the accuracy of the documentation and reliability of the procedure of the documents and freedom from errors. It can be concluded that credibility in research serves as evidence free from error and distortion. In order to ensure credibility of the study, the researcher conducted member checks with the participants to ensure that the data collected were a true reflection of the participant's views. Member checking was also employed were taken to the participants so that they could determine whether their ideas and opinions were presented accurately. The participants' comments were also included in the report. Therefore, credibility of this study was strengthened because participants were given an opportunity to react to the data, as well as to the final report.

Credibility is an indication that the conclusion from data collected in terms of interviews and observations are accurate (Maree, 2010). The credibility criterion ensures that the results are believable from the perspective of the participants in the study (Trochim, 2006). The main point to consider is how congruent and how believable the findings are, based on the data obtained and the conclusions drawn. Merriam (2002) states that in qualitative research, the findings of the study are interpreted through words, expressions or numbers gathered from the participants. She suggests that the meaning of the interpretation needs to be grounded on the participants' experiences and shared perceptions. Lincoln (2005) offers specific methods and strategies in which to accomplish credibility in qualitative research. These strategies include:

I. member checks – All the data to be collected from the investigation was transcribed verbatim and was taken back to the interviewees for verification, to ensure whatever statements given and observations made during the interview, are accurate;
II. prolonged engagements in the field – Contact with the interviewees was not only during data collection sessions. The researcher made telephone follow-ups to establish the patterns on the finding; and
III. pilot study – The instruments that were used to collect data were piloted at senior primary schools (Lincoln 2005). Trustworthiness of the findings was addressed in line with Guba's model of trustworthiness as presented by De Vos and Seon (2008).

There four types of Guba's model of trustworthiness are:

(**a)*Truth value***: This asks whether the researcher has established confidence in the truth of the findings for the participants and the context of the study. In this study, truth value was achieved by using triangulation in data collection.

(b) *Applicability*: This refers to the degree to which the findings can be applied to other contexts and settings or with other groups. Applicability was achieved through the limitations presented at the end of this chapter.

(c) *Consistency*: This refers to whether the findings would be consistent if the enquiry was replicated with the same participants or in a similar context. In this research, consistency was achieved using the same methodology with the same research design.

(d) *Neutrality*: It is the freedom from bias in the research procedures and results.

3.8.2 Dependability

Dependability is focused on the process of the inquirer and inquirer's responsibility for ensuring that the process was logical, traceable and documented (Sherin, 2006).

According to Yin (2003) the emphasis is on doing same case over again, not on imitating results of one case by doing another case study. Another element of ensuring dependability of this study is to minimise both errors and bias in the study. In this study, the researcher ensured dependability by reading the themes over again to verify that they made sense and auditing the entire data transcripts as Seal (2004) emphasises that auditing transcripts provides the opportunity to engage in self-critical account of the events.

3.8.3 Confirmability

Voster and Prozesky (2001) see confirmability as a side of qualitative-oriented criterion for objectivity that indicates the degree to which the findings in qualitative research is the product of the focus of the inquiry, and not of the bias of the research. Therefore, data sources of the study as well as data collection tools were clearly described to ensure the confirmability of the study. Furthermore, Schwardt (2007) argues that it is concerned with establishing the fact that the data and interpretation of an inquiry is not merely a fragment of the inquirers' imagination.

3.9 DATA ANALYSIS

Data analysis is the process of systematically searching and gathering the interview transcripts, field notes and other materials that the researcher accumulates during data collection, in order to increase his or her understanding of the phenomenon and ultimately to be able to present what has been discovered to others (Bogdan & Biklen, 2007). According to Seliger and Shohamy, (2003) data analysis is the sifting, organising, summarising and synthesising of the data so as to arrive at the results and conclusions of the research. In this study, data were analysed contended concurrently with the data collection. Quantitative data analysis was done using descriptive statistics by calculating frequencies, percentages and means. Results were presented in tables, graphs and charts (Creswell, 2014). Qualitative data from semi-structured interviews and focus group discussions were analysed using thematic content analysis. Through this process, particular pieces of evidence led to meaningful wholes. Inductive analysis involved coding and categorisation of data, observing patterns and themes, and making reasoned conclusions. Coding with reading the data in each data set and identification of frames of analysis (Hatch, 2002). This means that data generated from the questionnaires were coded and analysed using descriptive statistics while data obtained from the focus groups and interviews were analysed qualitatively for emerging themes.

3.9.1 Framework for data analysis

To make analysis of data easy, the researcher made sure that the interview questions reflected the main objective of the study which was determining the impact of the curriculum change in teaching and learning of science. The questions were grouped according to their themes. The themes reflected the overall aim and objectives of the study and other main areas that arose from the reviewed literature. According to Bogdan and Biklen (2007) in Biggam (2011), dealing with qualitative data are described as working with data, organising it, breaking it into manageable units, synthesising it, searching for patterns, discovering what is important and what is to be learned, and deciding what you would tell others. Therefore, the researcher described and analysed the learners' and teachers' questionnaires findings and compared them with literature review findings, followed by the HoDs interview results. The researcher also described and analysed the observation results and compared them with literature review findings. Then the researcher compared the learners' and teachers' questionnaire results against HoDs' interview results. The questions were grounded on the teaching of NS concepts to English second language speakers. Under each theme, the HoDs of applicable schools were interviewed by the researcher using semi-structured interview questions. The interview technique was the key instrument used to collect data from the participants who were responsible for science learning area or subjects. Teachers responded to open-ended questionnaire items. According to Rule and John (2011), people are selected because of their relevant knowledge, interest and experience in relation to the study. The researcher decided to use questionnaires, interviews and observations as data collection techniques in this study. Data from all these techniques were analysed according to their themes to make analysis simple and easy. To achieve that, the researcher took detailed notes as participants talk. The researcher compared the learners' and teachers' questionnaire results against HoDs interview results.

3.10 ETHICAL CONSIDERATIONS

Ethics is a philosophical term derived from the Greek word ethos, meaning character or custom, and connotes a social code that conveys moral integrity and consistent values

(Parker, 2006). In relation to the ethics of science, Mouton (2001) is of the opinion that the ethics of science concerns what is wrong and what is right when conducting research. To this end, all researchers, regardless of research designs, sampling, techniques and choice of methods, are subjected to ethical considerations (Gratton & Jones, 2010). Ethics plays a major role in judging qualitative research because qualitative researchers spend a great deal of time with participants and should treat them with dignity (Silverman, 2000). According to Bryman (2008), ethics increases credibility of a study. Since the research was both quantitative and qualitative, there was anticipation of personal intrusion, thus; ethical considerations were prioritised. Policies regarding informed consent, deception, confidentiality, anonymity, privacy and care were adopted. The research design not only involved selecting informants but also adhered to research ethics (McMillan & Schumacher, 2010). All ethical measures were taken into consideration including informed consent, freedom to withdraw, confidentiality and anonymity, privacy and empowerment, and care and fairness:

Informed consent: Consent was sought from all participants, phase HoDs, teachers and learners. They were informed of the purpose of the study, the demands and risks of the study and were given all information that influenced their weariness to participate. To gain permission, participants signed a protocol for informed consent. Informants selected interview times and places so as to establish trusting relationships and handle the dialogue. The time required for participation was none interfering and was in as natural a setting as possible (McMillan & Schumacher, 2010).

Confidentiality and anonymity: Participants were assured that their identities, their responses would not be mentioned or revealed in this research study. Pseudonyms were used to report findings. Data collected were analysed on an aggregate basis without delineating the school or respondent. The settings and participants were disguised so as to appear similar to several possible places and give code names of people and anonymity is requested. There was dual responsibility to protect the individual's confidence from other persons in the setting, and to protect the informants from the general reading public. In this survey research, there was dissociation of names from responses during the coding and recording process (Creswell, 2009).

Privacy and empowerment: The research participants were informed that they were free to withdraw from the research study at any time without penalty. There was negotiation with participants so that they understand the power that they have in the research process. The power and the mutual problem solving from the results may be an exchange for the privacy lost by participating in the study (Lincoln, 2005).

Care and fairness: Open discussion and negotiations were carried out to promote fairness to the participants and to the research inquiry. A sense of care and fairness was being part of the researcher's thinking actions and personal morality in the research (McMillan & Schumacher, 2010).

3.11 CHAPTER SUMMARY

This chapter focused on the research design and methodology that underpinned this study. Detailed information regarding the mixed methods design, its origins, its relevance to this study, and its general characteristics, were explored in this chapter. The following chapters build on from the methodological propositions made in this chapter by employing the proposed data presentation and analysis approaches to analyse the quantitative and qualitative data. The researcher specified the choice of both approaches and clarified why he opted to use the said approaches. The researcher also stated differences between qualitative and quantitative approaches and motivation for the use of both approaches.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

The previous chapter discussed the research methodological decisions premised on pragmatic paradigm, applying a mixed method approach, and the concurrent triangulation design. In this chapter, the data gathered formed the empirical evidence of the research which were then presented and analysed so that interpretations could be made. This chapter engages in discussion and interpretation of data to answer the sub problems and the major problem. The aim of this study was to examine the teaching of Natural sciences concepts to English second language speakers in selected primary schools in the East London Education District Eastern Cape Province of South Africa. The objectives of the study were to identify the extent to which language skills are integrated in the teaching of Natural Sciences in the classroom. Establish whether the current Science teachers' practices in helping the learners acquire language skills in the language of Science concepts. And the language of teaching and learning are in line with recommendations by studies and the Department of Basic Education. This research is a mixed methodology and the following steps were followed according to McMillan and Schumacher (2010): collection and organizing of the data, transcribing the data into segments, data coding, describing the data classifying and finally developing patterns. In such a way that the data were analysed both qualitatively and quantitatively with concurrent triangulation design to look at both qualitative and numerical (statistical) results. Data are presented from the questionnaire on the quantitative side administered on learners and teachers. And on the qualitative 8 senior phase HoDs particularly grade 7 and 40 grade 7 learners eight per school for focus group. The last section covered the sub-research questions which included how teachers link the teaching of NS concepts to learners' prior knowledge, learner- centred strategies utilised in the teaching and learning of NS concepts, strategies employed by teachers assist learners in learning NS concepts, challenges teachers encounter in the teaching and learning of science concepts and assess the implications for science education.

When collecting data, the researcher ensured that transcripts of data collected were kept,. The reason for this was that it is difficult in future to remember everything said in interviews, questionnaires and in the classroom, if written data is not kept. Keeping records enabled the researcher to refer to them when the need arose. The questionnaire for learners and teachers had two sections; section A covered biographical variables of the respondents, and the last two sections solicited views on challenges teachers and learners encountered during teaching and learning of NS concepts.

4.2 BIOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS

This section presents the biographical information of the respondents; that is both learners and teachers. The biographical profile of the respondents covered their gender, age, highest qualifications, highest professional qualifications, positions or responsibilities at school and NS teaching experience. The responses to the personal information had no direct impact on the purpose of the research as they were prearranged. Therefore, answers as imagined the research information was valuable to the reader in the discoveries. The biographical information is presented to contextualise the findings of the study. The learners and teachers who responded in this study were purposefully chosen. The biographic characteristics provided the context in which information was gathered. The biographical data of teachers and learners is presented in Tables 4.1 and 4.2.

4.2.1 Biographical details for teacher respondents

Table 4.1 presents a summary of the biographical details of teacher respondents by looking at respondents according to variables such as gender, age, academic and professional qualifications, among others.

Table 4.1: Distribution of biographical characteristics of teacher respondents

Variable	Descriptive	Frequency	Percentage
Gender	Male	36	53.3
	Female	28	43.8
Total		**64**	**100**
Age	25 years below	0	0
	26-30 years	3	4.7
	31-35 years	4	6.3
	36-40 years	17	26.6
	41-50 years	34	53.1
	51 years and above	6	9.4
Total		**64**	**100**

Highest Academic Qualifications	A- Level	1	1.6
	Bachelor’s degree	51	79.7
	Master’s degree	7	10.9
	Doctoral degree	0	
	Other	5	7.8
Total		**64**	**100**
Highest Professional Qualification	Certificate	2	3.1
	Diploma	62	96.9
Total		**64**	**100**
Position of Responsibility	Subject teacher	45	70.3
	Class teacher	10	15.6
	Head of department	2	3.1
	Senior teacher	7	10.9
Total		**64**	**100**
NS teaching experience	Below 1 year	0	0
	1-2 years	5	7.8
	3-4	17	26.6
	5-6	23	35.9
	7 years and above	19	29.7
Total		**64**	**100**

Table 4.1 starts by setting out the gender of the teachers that indicates 36(53.3%) of the teacher respondents were male and 28(43.8%) were female. This reflects that there were more male than female respondents involved in the teaching of NS in grade 7 classes of senior phase. The importance of including gender in this study was to guarantee that the respondents to the questionnaire were inclusive of both male and female participants. The respondents were purposefully selected for the reliability of their information. For the purposes of this study, the participation of both male and female teachers was important as it allowed the researcher to develop collected opinions, perceptions and experiences on their role in the teaching of NS concepts.

An analysis of the age of the teacher respondents reveal that 57(89%) were older than 35 years in the manner that only 7(11%) were around 26-35 years of age. The age of the respondents was viewed in relation to their teaching experience. These responses in relation to age and teaching experience indicated that the respondents to the questionnaire were mostly mature and experienced teachers who were able to respond, with some extent of authority, to the topic. Whereas there were no NS teachers younger than 25 years of age, otherwise they have no teaching experience. On the part of highest academic qualifications, teacher respondents were well-qualified for the teaching profession that is three years training (Diploma in Education) 62(96.9%), and only two teachers (3.1%) being underqualified teachers. Gathering responses from qualified NS teachers was considered important in answering the study's research questions.

The same table, Table 4.1 indicates the majority of teacher respondents were subject teachers 45(70.3%), 10 class teachers all post level one. 2(3.1%) were heads of department (HoDs) post level twos and 7(10.9%) senor teachers with more experience.
Table 4.1 also shows the number of years the respondents had been teaching NS. Overall, the experience in teaching the subject was three to six years 40(65.5%), 7 years and above 19(29.7) and one to two 5(7.8). Three to 7 years above experience, could have an important effect in their ideas about the teaching of natural sciences concepts to English second language learners in primary schools

4.1.2 Biographical details for learner respondents

Table 4.2 presents a summary of the biographical details of learner respondents according to variables such as gender and age, among other variables. There were eight schools that participated in the study, which constituted ten percent (10 %) of East London village primary schools. The learners' questionnaire was completed by 253 grades 7 NS learners.

Table 4.2: Biographic characteristics of learner respondents

Variable	Description	Frequency	Percentage
Gender	Male	118	46.6
	Female	135	53.4
Total		**253**	**100**
Age	13 and below	193	76.3
	14-16	52	20.6
	17 and above	8	3.2
Total		**253**	**100**
School pupil composition	Boys only	0	0
	Girls only	0	0
	Mixed gender	253	253

Total		**253**	**100**
School position of responsibility	Head boy/girl	2	0.8
	Vice head boy/girl	0	0
	Prefect	4	1.5
	Class monitor	2	0.8
	No position of responsibility	245	96.8
Total		**253**	**100**

Table 4.2 above shows the gender distribution of the sample of NS learners who participated in the study. It indicates that the research sample consisted of more girls than boys, that was 135(53.4%) girls and 118(46.6%) boys. It was interesting to see that many female learners were interested in learning NS than boys. There was no need to include the race variable because all the learners were coming from the black village schools and were isiXhosa speakers learning in English as FAL.

Age indicates that most learners in this study were 13 years and below 193(76.3%), and the medium learners of 14 to 16 years were 52(20.6%), with fewer learners being 17 years of age 8(3.2%) above the age of grade 7 class. It was interesting to note that these young learners studied NS, deemed by government as one of the fields of study associated with the future development of the country. In terms of school pupil composition, the study was done in mixed-gender schools.

A considerable number of learner respondents held different school positions of responsibility ranging from class monitor 2(0.8%), school prefects 4 (1.5%%), and no position 245(96.8) learners. Out of eight schools, only four schools had school position of responsibility.

4.3 HOW TEACHERS LINK THE TEACHING OF NATURAL SCIENCES CONCEPTS TO LEARNERS' PRIOR KNOWLEDGE

This section presents teachers' and learners' views on how teachers link teaching of Natural Sciences concepts to learners' prior knowledge. The researcher distributed the questionnaires to teachers and learners and left them to respond in a relaxed manner away from him. Data from the teacher's and learner's questionnaires were analysed using descriptive statistical methods involving percentages, means, and standard deviations where appropriate. Responses to the open-ended questions were coded into categories and the frequency of teachers' and learners' responses in each category was determined. Table 4.3 presents results on teachers' views on the link between teaching and learning of NS, and learners' prior knowledge.

4.3.1 Quantitative results on how teachers link the teaching of natural sciences concepts to learners' prior knowledge

Results based on how teachers link the teaching of natural sciences concepts to learners' prior knowledge as sub- research question number one aimed to examine the teaching and learning of NS concepts to grade 7 English second language learners. Educators and learners gave their responses regarding instructional approaches they used in the teaching and learning NS concepts. In the first column, statements are not stated in full to save space but are stated below the table before the interpretation of the findings. The focus of the study add on the measured rationale of English second language speakers to acquire knowledge when learning takes place through teaching and learning of NS concepts payable to rational translations that must be undertaken. Questionnaires were of different forms, from tick boxes to free text responses and honest opinion-based responses. Respondents were given the questionnaires to fill in and the researcher collected them afterwards. Quantitative data gained through the questionnaires were presented in tables 4.3 and their analyses are given below each table, while the results of interviews are transcribed and presented thematically in the paragraphs.

Table 4.3: Teachers views on how teachers link the teaching of natural sciences concepts to learners' prior knowledge

Key: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD)

LINKING OF TEACHING OF NS CONCEPTS	SA 4	A 3	D 2	SD 1	TOTAL	MEAN	SD
Teachers link the teaching of Natural Science concepts to learners' prior knowledge.	11 (17.2)	49 (76.6)	2 (3.1)	2 (3.1)	64	3.08	0.57
Lessons in English complicate our pupils' understanding of scientific concepts.	16 (25.0)	26 (40.6)	16 (25.0)	6 (9.4)	64	2.81	0.92

English as a language of teaching, influences interaction in Natural sciences classroom.	5 (7.8)	55 (85.9)	4 (6.3)	0	64	3.02	0.38
Attitudes of teachers affect the effectiveness of science curriculum.	19 (29.7)	26 (40.6)	18 (28.1)	1 (1.6)	64	2.98	0.81
Curriculum affect teaching and learning of Natural sciences concepts.	12 (18.8)	33 (51.6)	19 (29.7)	0	64	2.89	0.69
Learners show interest in learning natural sciences concepts.	2 (3.1)	45 (70.3)	13 (20.3)	4 (6.2)	64	2.70	0.63
New Natural sciences concepts are linked to what students already know.	4 (6.3)	24 (37.5)	28 (43.8)	8 (12.5)	64	2.38	0.79
Topics in NS are based on the core knowledge, concepts and unifying statements set out in the NS policy document.	16 (25.0)	38 (59.4)	8 (12.5)	2 (3.1)	64	3.06	0.71
Core knowledge and concepts of NS develop an interest in learners studying NS related subjects.	4 (6.3)	32 (50.0)	17 (26.6)	11 (17.2)	64	2.45	0.85

(Key: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD)

On the view that teachers link the teaching of Natural sciences concepts to learners' prior knowledge, most of the teacher respondents 60(93.8%) confirmed teachers linking the teaching of Natural sciences concepts to learners' prior knowledge. On the contrary only a small minority of the teacher respondents 4(6.2%) disagreed with the view. This shows that the issue of teachers linking the teaching of Natural sciences concepts to learners' prior knowledge was considered, without doubt, as a challenge in science teaching and learning. With a mean of 3.08, it further shows that the average response to this question item was on the confirmation side.

On the view that lessons in English complicate pupils' understanding of scientific concepts, most of the teacher respondents 42(65.6%) confirmed that lessons in English complicated pupils' understanding of scientific concepts. On the contrary, only a minority of the teacher respondents 22(34.4%) disagreed with the view. This shows that the issue of lessons in

English complicating pupils' understanding of scientific concepts was considered as a challenge in science teaching and learning. With a mean of 2.81, it further shows that the average response to this question item was on the agreement side.

On the view that English as a language of teaching influences interaction in Natural sciences classroom, most of the teacher respondents 60(93.7%) confirmed by agreeing to the statement. On the contrary only a minority of the teacher respondents 4(6.3%) disagreed with the view. This shows that the issue of English as a language of teaching influence interaction in Natural sciences classroom was considered, without doubt, as a challenge in science teaching and learning. With a mean of 3.02, it further shows that the average response to this question item was on the agreement side.

On the view that attitudes of teachers affected the effectiveness of science curriculum, most of the teacher respondents 45(70.3%) confirmed the attitudes of teachers affect the effectiveness of science curriculum. On the contrary minority of the teacher respondents 19(29.7%) disagreed with the view. This shows that the issue of attitudes of teachers affecting the effectiveness of science curriculum was considered as a challenge in science teaching and learning. With a mean of 2.98, it further shows that the average response to this question item was on the agreement side.

On the view that curriculum affected teaching and learning of Natural sciences concepts, most of the teacher respondents 45(70.4%) agreed whereas a minority of the teacher respondents 19(29.7%) disagreed with the view. This shows that the issue of curriculum affect teaching and learning of Natural sciences concepts was considered, without doubt, as a challenge in science teaching and learning. With a mean of 2.89, it further shows that the average response to this question item was on the agreement side. On the view that learners showed interest in learning Natural sciences concepts, most of the teacher respondents 47(73.4%) agreed and few of the teacher respondents 17(26.5%) disagreed with the view. This shows that the issue of learners showing interest in learning Natural sciences concepts was considered, without doubt, as a challenge in science teaching and learning. With a mean of 2.70, it further shows that the average response to this question item was on the agreement side.

On the view that new Natural sciences concepts are linked to what students already know, most of the teacher respondents 36(56.3%) responded in the affirmative whereas a minority of the teacher respondents 28(43.8%) agreed with the view. This shows that the issue of new Natural sciences concepts being linked to what students already know was not considered, in such a way that there are challenges in science teaching and learning. The mean of 2.38 further shows that the average response to this question item was on the disagreement side.

On the view that topics in NS are based on the core knowledge, concepts and unifying statements set out in the NS policy document, most of the teacher respondents 54(84.4%) agreed while the minority of the teacher respondents 10(15.6%) disagreed with the view. This shows that the issue of topics in NS being based on the core knowledge, concepts and unifying statements set out in the NS policy document was considered, without doubt, as a challenge in science teaching and learning. With a mean of 3.06, it further shows that the average response to this question item was on the agreement side.

On the view that core knowledge and concepts of NS developed an interest in learners studying NS related subjects, most of the teacher respondents 36(56.3%) confirmed the statement with only a small minority of the teacher respondents 28(43.8%) disagreeing with the view. This shows that the issue of core knowledge and concepts of NS develop an interest in learners studying NS related subjects was considered, without doubt, as a challenge in science teaching and learning. With a mean of 2.45, it further shows that the average response to this question item was on the agreement side.

The next section presents quantitative results on learners' views on the teaching of Natural sciences concepts to English second language learners using their prior knowledge.

4.3.2 Quantitative results on learners' views on the teaching of natural sciences concepts to English second language learners using their prior knowledge

In this section on learners' views on the teaching of Natural sciences concepts to English second language learners using learners their prior knowledge. Section below, questionnaires were used to find the connection amongst learners' English competence and their understanding of Science concepts. In Table 4.4 responses on the scale item were also coded in relation to the items so that the number and percentage that responded strongly agree, agree, disagree and strongly disagree

Table 4.4: Learners' views on the teaching of natural sciences concepts to English second language learners using their prior knowledge.

Key: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD)

Statement on the link of learner's prior knowledge	SA 4	A 3	D 2	SD 1	TOTAL	MEAN	SD
Easily use of prior knowledge to understand scientific concepts	5 (2.0)	94 (37.2)	141 (55.7)	13 (5.1)	253	2.64	0.61
Help learners to learn by participation	15 (5.9)	161 (63.6)	73 (28.9)	4 (1.6)	253	2.74	0.59
Learners have mastered the required concepts	9 (3.6)	120 (47.4)	95 (37.5)	29 (11.5)	253	2.43	0.74
Helps the learners to respond intuitively	17 (6.7)	152 (60.1)	77 (30.4)	7 (2.8)	253	2.71	0.63
Learners are actively given feedback in communication, accuracy of knowledge, skills and thought process by the teacher.	5 (2.0)	166 (65.6)	71 (28.1)	11 (4.3)	253	2.65	0.59
Teacher shows confidence and knowledge in teaching the subject.	20 (7.9)	126 (49.8)	104 (41.1)	3 (1.2)	253	2.64	0.64

Key: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD)

On the view that learners easily used prior knowledge to understand scientific concepts, small manority of the learner respondents 99(39.2) confirmed with most of the learner respondents 154(60.8%) disagreeing with the view. This shows that the issue of the use of prior knowledge was considered, without doubt, as a challenge in science teaching and learning. With a mean of 2.64, it further shows that the average response to this question item was on the agreement side

Regarding the view that teachers helped learners to learn by participation, most of the learner respondents 176(69.5%) responded in the positive a small minority of the learner respondents 77(31.5%) disagreeing with the view. This shows that the issue of teachers helping learners to learn by participation was considered, without doubt, as a challenge in science teaching and learning. With a mean of 2.74, it further shows that the average response to this question item was on the affirmative side.

In line with the view that learners had mastered the required concepts, about half of the learner respondents 129(51%) agreed with the statement with fewer learner respondents 124(49%) disagreeing with the view. This shows that the issue of learners having mastered the required concepts was little bit considered, as a challenge on the link of learner's prior knowledge in teaching and learning of ns concepts. With a mean of 2.43, it further shows that the average response to this question item was on both agree and disagreement side, showing that learners had mixed views.

With regards to the view that the teacher helped the learners to respond intuitively, most of the learner respondents 169(66.8%) agreed with the statement with fewer learner respondents 84(33.2%) disagreeing with the view. This shows that the issue of the teacher helping the learners to respond intuitively was considered, without doubt, as a challenge in science teaching and learning. With a mean of 2.71, it further shows that the average response to this question item was on the agreement side.

With respect to the view that learners were actively given feedback in communication, accuracy of knowledge, skills and thought process by the teacher; most of the teacher respondents 171(67.6%) agreed with the statement, with fewer learner respondents 82(32.4%) disagreeing with the view. This shows that the issue of giving feedback in communication, accuracy of knowledge, skills and thought process by the teacher was considered, without doubt, as a challenge in science teaching and learning. With a mean of 2.65 it further shows that the average response to this question item was on the agreement side

With reference to the view that teachers showed confidence and knowledge in teaching the subject, many learner respondents 146(57.7%) confirmed the statement, with 107(42.3%) disagreeing with the view. This shows that the issue of teacher showing confidence and knowledge in teaching the subject was considered, as a challenge in science teaching and learning. With a mean of 2.64, it further shows that the average response to this question item was on the agreement side.

4.3.3 Qualitative results on how teachers linked the teaching of Natural sciences concepts to learners' prior knowledge

The qualitative data were analysed using the interpretative and coding system as mentioned above. Setati (2011) states that interpretative analysis is a process of close examination of data in order to find constructs, themes and patterns that address the researcher's research goal. The researcher presents data gathered using individual interviews with grade 7 NS HoDs (head of departments) and focus group discussions with 40 grade 7 NS learners and classroom observations. Data are then presented using themes and sub themes drawn from narratives, to answer the research questions. This is meant to get deeper understanding of teaching NS concepts, verify reviews and open-ended instruments responses. Interview results for HoDs and learners' focus group interviews are presented in this section. In this section, a thematic analysis was chosen as an appropriate data analysis method. Braun and Clarke (2006) define thematic analysis as, "a qualitative method for identifying, analysing and reporting patterns (themes) within data." The selection of this method was grounded on its ability to facilitate a detailed organisation and description of qualitative data. For example, H stands for HoD (head of department) respondents and FG for focus group learner respondents. Table 4.5 presents the main themes and sub-themes which are discussed in detail in the subsequent sections.

Table 4.5: Theme and sub-themes on the linking of natural sciences concepts to learners' prior knowledge

Theme	Sub-themes	Related issue
Teaching NS concepts	Learners prior knowledge. English second language learners	Learners that learn with English language whereas their mother tongue is isiXhosa.
	Understanding of scientific principles	Learners must be taught from known to unknown to test their prior knowledge.
	Factors affecting teaching and learning of NS	Language issue, over loaded classrooms, time allocation

Teaching and learning of NS concepts	language used during teaching and learning of NS understanding the NS concepts	Language used during teaching and learning NS as a subject is not the same as language taught, more especial to second language learners Very difficult to pronounce the NS concepts.

4.3.3.1 Learners prior knowledge

The head of departments involved in this study shared the same views on each of the questions. Out of eight HoDs interviewed, four showed an interest in using learner's prior knowledge during teaching NS concepts. In their response to the question relating to teaching of natural sciences concepts to English second language learners using their prior knowledge: the following emerged:

Learners have a grid understanding and some have a problem in understanding the English NS concepts especial unfamiliar terms. (H3)

Yes. teachers do identify /anticipate prior everyday knowledge related to the concept or topic. (H5)

Learning of science influences interaction among learners and affects their understanding of Science concepts. (H7)

Teachers sometimes ask questions that are related to the concept itself or use their surroundings as reference (H2)

The focus in this question was to establish the work done by the HoDs regarded the management skills of senior phase teachers in the teaching of NS using learner's prior knowledge. It emerged from the interviews that the schools had a challenge with the HoD's execution of duties in relation to teaching and learning of science subjects.

The focus group interviews for learners also showed the same views on teaching of Natural Science concepts using learner's prior knowledge. Once the learners are exposed to prior knowledge of the NS, they are expected to sustain the interest in the scientific understanding. A good science teacher uses review to introduce learners to the processes of obtaining new knowledge, such as observation, hypothesis and experimentation.

By asking learners about what they know about the topic on hand and further explain the misconception about the topic. Teachers need to make NS activities fun and more practical. (FG1)

If we have good foundation of English, it can become easy for us to follow the scientific instructions but because we struggle to follow the instruction. It is very difficult for us to be specific that we may use our prior knowledge. (FG4)

Learners' prior knowledge needs to be assessed since it always guides the teacher on the equal of data that they have need to be known. With this knowledge, the teacher sees which parts s/he wishes to stress before starting with NS concepts. Most teachers feel that practical experience of a phenomenon is essential for understanding scientific concepts. Active teaching must offer learners the potential to remember more material. Using what can be related to their prior knowledge, the teacher uses demonstration to take learners from the known to the unknown.

4.3.3.2 English second language learners

In response to the question: How do teachers link the teaching of Natural sciences concepts to learners' prior knowledge? Under the sub theme English second language learners which asked, the following responses were given from the senior phase HoDS:

Second language learners are not able to read and write at the expected levels and are unable to execute tasks that demonstrate skills associated with NS. (H6)

Furthermore, respondents pointed out that some of learners were unable to explain In most science in the classroom when the teacher is teaching. After the class, they drop their books and wait for the next class.

Four of the HODs commented that they tried to let learners use their senses by listening, observing, and making drawings before writing.

English is not our language that is why we find difficulties when we learn. (FG6)

Teachers should discuss the language issue in class and guide us about language issues (FG4)

We speak our mother tongue to our parents at home (FG3)

Teachers understood that to get all learners involved in the lesson, they had to simplify concepts and start with what learners already knew and then move step by step towards those concepts that were new to them.

4.3.3.3 Understanding of scientific principles

When the HoDs requested to give scientific principles, participants had a shared knowledge that learners not only need to become proficient in the language of learning and teaching, but also have a huge problem with science terms in the language of learning and teaching. Three of the HoDs' responses were:

As senior phase educator, we know science is one of the subjects that you get points with when you apply at the university. That is why learners need to memorise sometimes even if they do not understand the meaning. (H3)

Learning with understanding is facilitated when new and existing knowledge is structured around the NS concepts. (H9)

I notice that teachers have more enthusiasm in using the new concepts whilst they are teaching. (H1)

Whereas learners mentioned that science is for the gifted or those learners who tend to link language development and science principles. They seemed to like NS as a subject and motivated themselves by saying:

We have different strategies, approaches, abilities and learning styles that are function of the interaction in our prior knowledge. (FG1)

From the understanding of scientific principles, developing scientist and others have been produce underlying principles of NS concepts.

4.3.3.4 Factors affect teaching and learning of NS

When talking about second language learning, there are several factors that influence the learning in a new language. Some of the factors are teaching style to ensure that learners benefit from science instructions. Learning styles include the character of learners that are different in learning and is very important for teachers to be attending to the diversity of the learners. Knowing the learners' background is very important during teaching and learning as almost all HoDs commented:

Respondents indicated that they did not receive the required supportive material they needed:

Learners relied on concrete substances to learn better. (H7)

Language is factor because melting and dissolving are not clearly differentiated in isiXhosa (H2)

To the factors listed above, HoDs noted that learners' fluency in the language of learning and teaching is a crucial factor in determining achievement. During classroom activities and lesson delivery, teachers need to show the value of NS as an important subject depending on the availability of resources. NS needs more practical for learners to understand.

Our teachers must make sure when teaching science that learners have difficulty to understand so they must try to use dictionaries in each word so that we must understand and enjoy the teaching. (FG2)

Using textbooks is a worst part. We took too much time in trying to understand the topic (FG6)

Two groups of learners stated that it would be helpful for them to have someone to guide and assure them that they were on the right track when they used their science resources for their homework.

Dealing with the second language learners, teachers must be very creative in making space and time for learners' varying strategies to improve the learning process. In this study, teachers had the responsibility to introduce different methods. This confirmed Ormrod's (2014) findings in the literature review that schools in the low-income communities are mostly poor-quality schools, poorly funded and lack equipment and a maintenance

4.3.3.5 Language used during teaching and learning of NS

Language used during teaching and learning of NS is English. In the South African language policy, the Department of Education (DoE, 2007) stipulated that learners should be taught in mother tongue (MT) in the foundation phase (grade 1-3) and one official language can be done as subject to promote additive approach.

Quality teaching requires teachers who are competent and have adequate knowledge and skills needed for effective classroom management, pupil assessment, subject teaching, and those who engage in regular professional learning. On the question of, how do the teachers link the teaching of natural sciences concepts to learners' prior knowledge? The HoD respondents under the sub theme mentioned that:

We use English when teaching NS, but we see the faces of our learners and notice that they are not following the lesson and we change to isiXhosa. (H6)

Policy stated that grade 7 (senior phase) must be taught in English but most of the time teachers code switch because learners do not follow the rules (H6)

Language used during teaching and learning of NS on the learner's respondents:

In our school, the language of teaching and learning is English but us we like isiXhosa for better understanding (FG7)

We take a lot of time to follow the instructions during the NS period. (FG4)

On the questions based on language used during teaching and learning of NS all the learners responded that they were not happy with the language used saying that it took a lot time to be understandable. They also mentioned that it was very difficult for them to get higher levels.

4.3.3.6 Understanding the NS concepts

Teachers are unable to understand the examination questions, nor are they able to communicate their answers in a logical way as science requires one to grasp the concepts and be able to communicate them in writing.

The language used for teaching is not understandable to most learners, and this makes it difficult for them to understand exam questions because we are not expected to explain anything to them during exams. (H3)

Learners explained that the science language contains difficult terms that are rigid to understand. Learners showed opinions of NS as learning subject held. Learners mentioned that continues assessments are important to match with intervening purposes for science teaching and learning. Understanding the NS concepts is shown in valuation of concepts, processes and problem-solving, below are some of the learners' responses:

We are not good in science because we are far from school and don't get time for evening classes. Even though we work as group, but it does not make any difference. (FG8)

Another thing is teachers did to bring us closely to them so that we can get exactly a clear picture about what we learn in the class. (FG6)

We like to learn with IsiXhosa for us as village learners because is difficult to understand some words in English, especially during test and practical activities. (FG1)

We are not comfortable because NS during teaching and learning, there are some words that just pass without understanding. (FG3)

Pronouncing the difficult words and there are words that could not be translated to home language. (FG8)

Responses of learners indicated above meant that they did not understand the science language, and they needed a lot of time to grasp the scientific concepts. The learners also singled out practical investigations as an aid that might make their lessons understandable because practical investigations clarified and reinforced the scientific concepts and enhance the learner's interest.

4.3.4 Document analysis on teaching of NS concepts

Document analysis involved the analysis of documents relating to the Curriculum and Assessment Policy Statement (CAPS), school assessment practices and policy, assessment instruments, assessment records and results. The researcher analysed the documents to determine whether they complied with policy requirements and proper NS teaching. Furthermore, he examined and analysed the documents to enrich the data were collected from interviews and classroom observations. The documents requested were CAPS policies, guiding documents used to teach NS based on concepts, assessment plans, curriculum coverage report, mark record sheets, mark schedules, formal assessment tasks moderation tools, monitoring and control of written work tools, report on control of workbooks and monitoring plans. Analysis and interpretation of the above-mentioned documents was carried out separately for each school.

4.3.5 Main findings on how teachers linked the teaching of Natural sciences concepts to learners' prior knowledge

Responses to both quantitative and qualitative questions found how teachers link the teaching of natural sciences concepts to learners' prior knowledge revealed that there is a linking of teaching NS concepts to learners that inform the approach. The teaching of NS concepts started from the learner's prior knowledge to what the learners already knew. It was also generally supposed that linking the teaching NS concepts to learners had positively affected role learner's prior knowledge. Table 4.5 presents the main findings on how teachers linked the teaching of Natural sciences concepts derived from quantitative and qualitative data.

Table 4.6: Triangulation table of findings from quantitative and qualitative data

Findings (Quantitative data)	Findings (Qualitative data)
Teachers and learners agreed that when they start teaching, they link with prior knowledge.	Affirmed how teachers linked the teaching of Natural sciences concepts to learners' prior knowledge
Confirmed that teaching NS concepts to learners had positively affected role learners prior knowledge.	HoDs and learners showed an interest in using learners' prior knowledge during teaching NS concept
Teachers showed their subject knowledge and teaching experience in teaching NS concepts	Teachers showed their teaching skills and their positive attitudes in teaching NS, while learners grow up in a linked manner of understanding to what they know.
Teachers agreed that learners constructed the new knowledge by identifying their prior knowledge.	Teachers helped the learner to construct new knowledge by identifying their prior knowledge, scaffolding the learning of new concepts

4.3.5.1 Interpreting the triangulation table

From the quantitative data, teachers and learners noted that it was considered important to utilise learners' prior knowledge in the teaching and learning of NS concepts. Findings from qualitative data verified HoDs as the regarded management skills of Senior phase in the teaching of NS in this study. Using learner's prior knowledge with the execution of duties in relation to teaching and learning of science subjects, HoDs confirmed that using prior knowledge allowed learners to learn by participation. The highlighted techniques validated teachers' understanding of the link between the teaching NS concepts to learners' prior knowledge. Teachers perceived link between the teaching and learning of NS concepts that the teachers seemed like concentrating on what the learners already knew when asking open question. Teachers linked the teaching of NS concepts to learner's prior knowledge by showing the required skills like code-switching for learners to understand the scientific concepts.

4.4 RESULTS ON LEARNER-CENTRED STRATEGIES UTILISED IN THE TEACHING AND LEARNING OF NATURAL SCIENCES CONCEPTS

Teaching of Natural sciences concepts to English second language learners in primary schools had implications for science education and strategies that use learners at the centre. The study's sub-research question was, what learner-centred strategies are utilised in the teaching and learning of Natural sciences concepts? In this section, the researcher presents findings on strategies employed by teachers and learners in the teaching and learning of NS concepts. These results are presented in both the qualitative and quantitative data forms.

4.4.1 Quantitative results on learner-centred strategies utilised in the teaching and learning of NS concepts

Teaching of Natural sciences concepts to English second language learners requires different strategies. The responses below show the way teachers engaged the learners in teaching of NS concepts. This section presents results on teachers' and learners' views on learner-centred strategies utilised in the teaching and learning of Natural sciences concepts. Table 4.7 presents results of teachers' views on strategies that utilised in teaching and learning of NS concepts.

Table 4.7: Teachers view on strategies that are utilised in the teaching and learning of natural sciences concepts

Key: Yes(Y), Maybe (M), No (N), Unsure (U),

learner-centred strategies in teaching and learning of Natural Science concepts	**Y 4**	**M 3**	**N 2**	**U 1**	**TOTAL**	**MEAN**	**SD**
Utilize relevant methods carry knowledge and skills across.	5 (7.8)	21 (32.8)	26 (40.6)	12 (18.8)	64	3.30	0.87
Teachers view teaching as telling and learning in Natural sciences	0	10 (15.6)	27 (42.2)	27 (42.2)	64	2.66	0.84
Science teachers should make use of inquiry in teaching to challenge learners.	11 (17.2)	17 (26.6)	34 (53.1)	2 (3.1)	64	3.58	0.81
Learners get support from home in their learning of science.	4 (6.3)	10 (15.6)	5 (7.8)	45 (70.3)	64	2.30	1.22
Teaching of natural sciences in English increase the learner's confidence in school.	0	12 (18.8)	17 (26.5)	35 (54.7)	64	2.36	1.08
Learners are prone to rote, learn and memorise facts and concept without understanding.	2 (3.1)	4 (6.3)	22 (34.4)	36 (56.2)	64	2.39	0.95
Teachers provide interesting methods together with a learning environment using models, simulating, diagrams and concepts maps	13 (20.3)	20 (31.3)	27 (42.1)	4 (6.3)	64	3.66	0.88

Students participate in the carrying out of experiments in science learning	6 (9.3)	7 (10.9)	27 (42.2)	24 (37.6)	64	2.86	1.02
Teaching approaches employed are useful in enhancing student learning of science	0	4 (6.3)	25 (39)	35 (54.7)	64	3.50	0.64
Learner-centred education is perceived as more suitable than traditional forms of education	10 (15.6)	24 (37.5)	25 (39)	5 (7.9)	64	3.61	0.85
Some strategies could be used to facilitate comprehension of Natural Sciences concepts with ESL learners	7 (10.9)	19 (29.7)	22 (34.4)	16 (25.0)	64	3.27	0.96
The teacher makes use of teaching strategy to allow the learners to study the words critically and conceptually	4 (6.3)	10 (15.6)	34 (53.1)	16 (25.0)	64	3.03	0.82

Regarding the view that teachers utilise relevant methods to impart knowledge and skills few of the teacher respondents 26(40.6%) confirmed by sayig yes teachers utilise relevant methods to carry knowledge and skills across when teaching and learning of NS concepts. whereas the majority of the teacher respondents 38(59.4%) says no with the view of teachers utilize relevant methods. This shows that to utilise relevant methods was considered, without doubt as a challenge in teaching of NS concepts. With a mean of 3.3.

In line with the view that teachers viewed teaching in Natural sciences as telling, few of the teacher respondents 10(15.6%) confirmed by saying yes to the issue of teachers view teaching as telling and learning in NS. On the contrary of majority of the teacher respondents 54(84.4%) saying no with the view. This shows that the issue of teachers viewing teaching as telling Natural sciences was not considered by the teachers as one of the strategies in teaching and learning of Natural sciences concepts. With a mean of 2.66, it further shows that the average response to this question item was a challenge.

With regard the view that Science teachers should make use of inquiry in teaching to challenge learners, least of the teacher respondents 28(43.8%) confirmed by saying that when science teachers make use of inquiry in teaching to challenge learners, they are doing excellent teaching. But on the contrary, many teacher respondents 36(56.2%) were saying no with the view. This shows that the issue of science teachers making use of inquiry in teaching to challenge learners, without doubt, was a challenge in science teaching and learning. With a mean of 3.58, it further shows that the average response to this question item was on the negative side.

Reference to the view that learners get support from home in their learning of science, few of the teacher respondents 14(21.9%) confirmed by saying yes learners get the support from home. On the contrary, majority of the teacher respondents 50(78.1%) said that learners did not get the support from home. This shows that the issue of learners getting support was considered. There is a challenge in learner support from home in their learning of science. With a mean of 2.30, it further shows that the average response to this question item was on the poor support.

On the view that teaching of Natural sciences in English increases the learners' confidence in school, few teacher respondents 12(18.8%) confirmed by saying yes that indeed the issue of teaching of Natural sciences in English increased the learner's confidence in school. On the contrary, 52(81.2%) teacher respondents saying no with the view of teaching of NS in English increase the learner's confidence. This shows that the issue was not considered by teachers. It is a challenge in teaching of natural sciences in English teaching. With a mean of 3.36, it further shows that the average response to this question item was on the negative side.

With respect to the learner's view are prone to rote, learn, memorise facts and concepts without understanding 6(9.4%) teacher respondents confirmed by saying yes, while 58(90.6%) teacher respondents were saying no with the view that learners are prone to rote, learn, memorise facts and concepts without understanding. It shows that learner-centred strategies in teaching and learning of NS concepts was not considered. There is a challenge in teaching and learning of NS concepts. With a mean of 2.39, it further shows that the average response to this question item was on the negative side.

On the view that teachers provided interesting methods together with a learning environment using models, simulations, diagrams and concept maps; more of the teacher respondents 33(51.6%) confirmed by saying yes, and few of the teacher respondents 31(48.4%) disagreed with the view. This shows that the issue of strategies in teaching and learning of Natural sciences concepts is seen as a challenge in science teaching and learning. With a mean of 3.66, it further shows that the average response to this question item was on the agreement side.

In line with the view that students participated in the carrying out of experiments in science learning, some teacher respondents 13(20.3%) were saying yes students participate in the caring out of experiments in science learning, whereas majority of the teacher respondents 51(79.8%) were saying no, learners did not carry out the experiments in teaching science. This shows that the issue of students participating in experiments was considered as a challenge in science learning. With a mean of 2.86, it further shows that the average response to this question item was on the no side.

Regarding the view that teaching approaches employed were useful in enhancing student learning of science, 4(6.3%) teacher respondents confirmed while the majority of the teacher respondents 60(54.7) saying no on the view that teaching approaches employed were useful. This shows that the issue of teaching approaches employed was considered as a challenge in science learning. With a mean of 3.50, it further shows that the average response to this question item was on the no side.

On the side view that learner-centred education is perceived as more suitable than traditional forms of education, more of the teacher respondents 34(53.1%) saying yes that indeed the issue of learner-centred education is perceived as more suitable than traditional forms of education. On the contrary, only a least of the teacher respondents, 30(46.9%), disagreed with the view. This shows that the issue of learner-centred education was considered as a challenge in science teaching and learning. With a mean of 3.61, it further shows that the average response to this question item was on the agreement side.

On the view that some strategies could be used to facilitate comprehension of NS concepts with ESL learners, few of the teacher respondents 26(40.6%) confirmed by saying yes with a majority of the teacher respondents 38(59.4%), saying no that some strategies could be used to facilitate comprehension on NS concepts. This shows that the issue of strategies could be used to facilitate comprehension of NS concepts with ESL learners was considered as a challenge with ESL learners. With a mean of 3.27, it further shows that the average response to this question item was on the negative side.

On the view that the teacher makes use of teaching strategies to allow the learners to study the words critically and conceptually, few of the teacher respondents, 14(21.9%), saying yes, while50(78.1%) saying no with the view of teachers make use of teaching strategies to allow the learners to study the words critically and conceptually. This shows that the issue of teaching strategies was considered, as a challenge in science teaching and learning. With a mean of 3.03, it further shows that the average response to this question item was on the agreement side.

Table 4.8: Learners views on Learner-centred strategies utilised in the teaching and learning of natural sciences concepts

KEY: *Every Time (EV), Sometimes (S), Never(N)*

LEARNER-CENTRED STRATEGIES TEACHING AND LEARNING OF NATURAL SCIENCES CONCEPTS	ET 3	S 2	N 1	TOTAL	MEAN	SD
learners are encouraged to play an active role in the classroom activities	2 (0.8)	115 (45.5)	136 (53.8)	253	2.30	081
Learners understand of the meaning of the natural sciences concepts	0	155 (61.3)	98 (38.7)	253	2.77	0.83
Teachers engage learners during learning and teaching natural sciences	0	144 (56.9)	109 (43.1)	253	2.58	0.95
Learners are always actively involved in the learning process of NS concepts	0	135 (53.3)	118 (46.6)	253	2.44	0.83

NS concepts are in tune with accepted scientific explanations.	**0**	**186 (73.6)**	**67 (26.5)**	**253**	**2.87**	**0.82**
Effective teaching and learning is a product of various interactions between the teacher and the learner	**0**	**115 (45.4)**	**138 (54.5)**	**253**	**2.38**	**0.77**
Teaching and learning is a two-way process with the learner and educator working together	**0**	**99 (39.1)**	**154 (60.9)**	**253**	**2.23**	**0.75**
Learners work as groups in the classroom during teaching and learning of NS	**6 (2.4)**	**139 (54.9)**	**108 (42.7)**	**253**	**2.54**	**0.75**

Table 4.8 above shows that learner-centred strategies utilised in the teaching and learning of Natural sciences concepts start on the view that learners are encouraged to play an active role in the classroom activities. A minority of the learner respondents 117(46.3%) confirmed by saying every time learners are encouraged to play an active role in the classroom activities. Most of the learner respondents 136(53.8%) learners never played an active role during teaching and learning of NS concepts. This shows that teachers do not encourage learners, that means the issue of learner centred was not considered by the teachers when teaching and learning NS concepts, without doubt, there is a challenge in teaching and learning of NS concepts. With a mean of 3.30 it further shows that the average response to this question was on the never side

On the view that learners understanding the meaning of the Natural sciences concepts, most of the learner respondents 155(61.3%) confirmed by saying every time the issue of learner understanding the meaning of practical activities as one of the strategies in teaching and learning of NS. Only a small minority of the learner respondents 98(38.7%) did not understand the teaching strategies. This shows that the issue of using the strategies, meaning of the Natural sciences concepts was considered as not a challenge in science teaching and learning. With a mean of 2.77, it further shows that the average response to this question item was on every time side.

Regarding the view that teachers engage learners during teaching and learning Natural sciences concepts, most of the learner respondents 144(56.9%) confirmed that everytime teachers engage learners in teaching and learning natural sciences was one of learnercentred strategies. On the contrary only a small minority of the learner respondents 109(43.1%) said never to the view of learner engagement. This shows that the issue of engaging with learning and teaching Natural Sciences as a strategy was consideredas a challenge in science teaching and learning. With a mean of 2.58, it further shows that the average response to this question item was on every time side

In line with the view that learners must always be actively involved in the learning process, most of the learner respondents 135(53.3%) confirmed by saying every time. On the contrary, a minority of the learner respondents 118(46.6%) said 'never' to the view. This shows that the issue of learners always actively involved in the learning process was considered a challenge in science teaching and learning. With a mean of 2.44, it further shows that the average response to this question item was on 'every time' side.

With respect to the view that learner centred strategy construct are in tune with accepted scientific explanations, most of the learner respondents 186(73.6%) confirmed by saying 'every time'. On the contrary, 67(26.5%) learner respondents said 'never' to the view. This shows that the issue of constructs being in tune with accepted scientific explanations was considered as a challenge in science teaching and learning. With a mean of 2.87, it further shows that the average response to this question item was on every time side.

The view that effective teaching and learning is a product of various interactions between the teacher and the learner, fewer learner respondents 115(45.4%) confirmed by saying 'every time' and most of the learner respondents 138(54.5%) said 'never' to the view. This shows that the issue of effective teaching and learning being a product of various interactions between the teacher and the learner was considered as a challenge in science teaching and learning. With a mean of 3.38, it further shows that the average response to this question item was on the 'never' side.

Regarding the view that teaching and learning is a two-way process with the learner and educator working together, few of the learner respondents 99(39.1%) confirmed by agreeing while a small minority of the teacher respondents 154(60.9%) almost never with the view. This shows that the issue of teaching and learning as a two-way process between the learner and educator working together was considered, as a challenge in science teaching and learning. With a mean of 2.23, it further shows that the average response to this question item was on the almost never side

With reference to the view that learners work as groups in the classroom during teaching and learning of NS concepts, most of the learner respondents 145(57.3%) confirmed by saying ‘every time’ while a minority of the learner respondents 108(42.7%) said ‘never’ to the view. This shows that the issue of working as groups in the classroom was considered, without doubt, as a challenge in science teaching and learning. With a mean of 2.54, it further shows that the average response to this question item was on the ‘every time’ side.

4.4.2 Qualitative results on learner-centred strategies utilised in the teaching and learning of NS concepts

The main theme of learner centred strategies generated other sub-themes which included, school management team, different teaching approach, planning and structuring of NS and learner involvement. Table 4.9 presents the main theme and sub-themes which are further elaborated in the following sections.

Table 4.9: Theme and sub-themes on based on learner centred strategies

Theme	Sub-themes	Related issues
Learner centred strategies	Involvement-School management team	Ensure availability of teachers working together with learners
	Learner involvement	Learners work in groups. Positive participation done by learners.
		Practical tasks that they do as a group. Learners mentioned that they also work in small groups.
	Different teaching approach	Teachers use different approaches to accommodate all the learners
	Planning and structuring of NS curriculum	

The above theme was deliberately selected because the researcher intended to put emphasis on learner centred strategies with the hope that it might serve as guidance in the analysis of data.

4.4.2.1 School management team involvement

The question was: What learner-centred strategies are utilised in the teaching and learning of Natural sciences concepts?

Below are some responses from the interview question that focused on learner-centred strategies in connection with the involvement of SMT at school. Four of the HODs confidently expressed that:

SMT must be abreast in all teaching and learning activities taking place per grade per subject so as to oversee all shortcomings in NS working on hand with the subject teacher for better outcomes(H7)

Moreover, HoD respondents explained that school management support the learner centred strategy by saying:

School management should motivate both learners and teachers with support so as to encourage them to use their given strength in emphasising importance of science and make sure that the school produces science teachers and learners that are more creative, researchers and discounter (H6)

The above responses showed that HoDs had a significant role on learner-centered label that gets attached to teaching strategies, teachers, classes, learners and management. Learner-centered teaching engages learners in the hard, messy work of learning. The comment also showed that teachers teach learners how to think and be problem solvers.

On the same sub research question, focus group for grade 7 learners said:

The Head of Department is an exceptional person when it comes to teaching and learning of NS learning. HoDs excel in their duty but to us as learners, it is very difficult just to see their work makes it a point that all learners participate on teaching and learning. If you can now go to her class, you will find that there is reading time for all learners. I can say, yaa, actually they do their best. They lead by an example always hold meetings with the phase educators to teach them about the new developments in *how to teach learners, but there are no changes because of the language we are using. (FG7)*

In their response to the question involving encouraging and supporting effective teaching of NS among teachers, HoDs are responsible for the planning and organisation of their departments to ensure that departmental subjects are taught effectively and efficiently.

We sit down as NS teachers and look at the formats that we can use, and we agree on one method of planning. (H2)

Teacher participants indicated the influence they had during the teaching and learning when preparing the NS concepts teaching as a subject. Teachers knew their role and what was expected of them to do. Teachers need to always be ready, be prepared for moderation and for their syllabus coverage with the pace of the second language learners. And to submit the work before teaching to the phase HoD.

4.4.2.2 Different teaching approach

Teachers use different teaching and learning approaches that expand learner centred strategy. Educators employed different teaching and learning approaches which include the responses of HODs from the question of What learner-centred strategies are utilised in the teaching and learning of Natural sciences concepts under the sub-theme teachers use different teaching approach:

Learners struggle with understanding and using the language of learning and teaching NS concepts could influence the application of learner centred approach. (H8)

Yes, they are accessing and recalling information, observing, sorting and classifying. (H8)

Yes, approaches like demonstration, experiments, deductive approach and analysis of information practically, most cases like with energy and change. (H6)

And focus group discussion respond to the same question as follows:

We prefer IsiXhosa teaching in our group because of our background. It is difficult to understand some words in English, especially during test and practical activities. (FG6)

We are not comfortable in all English subjects, especially during teaching and learning of NS concepts. There are some words that just pass without understanding. (FG7)

HoDs were probed how often teachers employed learner-centred approaches in their teaching. They indicated that the use of language of instruction and lack of resources made them end up using teacher centred approaches. It was clear from the participants' responses that different teaching and learning approaches were employed but there were problems that made use of some learner-centred approaches impossible, such as lack of resources. Learners must take control of their own learning with the support of the teacher. Learner-centred approaches refer to approaches which consider and make provision for differences in prior knowledge and experience, styles of learning, home languages and competence in the language of teaching and learning NS concepts.

4.4.2.3 Planning and structuring of NS curriculum

Interview participants were asked about learner-centred strategies utilised in the teaching and learning of Natural sciences concepts with the selected theme of planning and structuring NS curriculum. HoDs reported that teachers work hard when they are planning so that their lesson accommodates the learners. The HoDs reported that:

Lesson plan guide the teachers on how to start a lesson, what acitities to give from which book to refere to. (H6)

The most important suggestion that I strongly recommend in planning NS in schools is to make it a habit for teachers in a phase to plan together, work hand in hand, and do assessment together so that the chain may not be broken in this curriculum. (H8) Lesson plans are written out on a weekly basis, describing the topic, learners' activities, resources, references and assessment tasks. (H1)

We also plan in terms so that management budgets for experiments and organise expects the needs and interests of the learner are central and the curriculum emerges from these needs and interests. (H3)

Participants from all eight schools reported that planning and structuring of NS curriculum teaching new subject content means the teacher must consider which approach is the most applicable and appropriate for achieving the desired lesson objectives. A lesson plan describes what the teacher intends to do in a specified period. It includes the topic, learning outcomes and assessment standards, teachers' and learners' activities, resources, assessment and time allocation.

Learners from focus groups on the side of learner centred teaching and learning of NS concept based on the planning and structuring of NS curriculum theme, learners commented that:

Effective teaching and learning aids are not available in our schools, when teachers are planning, they must make sure that all the resources and apparatus used must be available. (FG6)

4.4.2.4 Learner involvement

Learners are the major recipient of the teaching and learning process. On the question of learner-centred strategies utilised in the teaching and learning of NS concepts under the sub-theme learner involvement.

Learners are involved in teaching and learning of NS science. All the HoD respondents noted that:

Teacher guides the class discussion, helping the learners to pose their own questions, and to choose which ones should be investigated. (H8)

The learners are encouraged to design original investigations and provide their own data and conclusions. It is the learners who draw and decide which avenue to research further. (H4)

The learners then present their argument in a structure that requires evidence, backings and warrants to support their claims. (H3)

Throughout the strategy learners are engaged in the processes of doing, talking, reading and writing and are therefore developing the fundamental skills of science. (H7)

One of the purpose on this sub research question was to place the learner at the center of the teaching and learning experience. Learners must take control of their own learning with the support of the teacher concerning involvement in science learning. Learner respondents revealed that educators involved learners in NS learning.

We always see educators trying to let learners work as groups and at times, we do practical tasks by ourselves. (FG2)

We use text book method. (FG5)

Learners themselves confirmed being actively involved in learning NS:

We participate but it is not easy because we do not do some of the things since we do not have enough resources. (FG8)

It was clear that educators would in some way involve learners through projects and carrying out of experiments, but it was not always possible because of lack of resources and other constraints. This would lead educators to employ teacher centred approaches which were not very useful in science teaching.

Learners also confirmed that some of the concepts learnt in NS were unfamiliar to them

We are interested in things that are happening generally on earth, but we experience challenges with science concepts we do not understand. (FG2)

One of the roles of the learner-centred teacher is to set up a suitable environment in which learning can take place.

4.4.3 Main Findings Qualitative results on learner-centred strategies utilised in the teaching and learning of natural sciences concepts

The responses to both qualitative questions to found the results on the learner-centred strategies that utilised in the teaching and learning of NS concepts. Table 4.10 presents the main findings on learner-centred strategies utilised in the teaching and learning of natural sciences concepts.

Table 4.10: Triangulation table of findings from quantitative and qualitative data

Findings (Quantitative data)	**Findings (Qualitative data)**
Teachers use relevant methods to impart knowledge and skills, learners are encouraged to play an active role in science classroom.	Recommended relevant teaching methods that encourage learners to play active role in science learning.
Teachers view teaching as telling but learners have difficulties understanding the meaning of NS concepts.	Affirmed the view of teaching as telling but with learners finding it to difficult understand NS concepts.

Science teachers make use of inquiry in teaching to challenge and to engage the learners.	Concurred that teachers make use of inquiry in teaching, to challenge learners.
Learners do not get the support from home in their learning of science that makes learning a two-way process between learners and teachers.	Complained of getting parental support from home in their learning of science.
Teaching of NS in English decreases the learners' confidence in school.	Lack of resources decreases the learners' confidence.
Learners learn science without understanding.	Confirmed that learners memorise without understanding science concepts.

Table 4.10 presents a summary of both quantitative and qualitative findings on learner centred strategies utilised in the teaching and learning of natural sciences concepts.

4.4.3.1 Interpreting the triangulation table

From the quantitative data, both teachers and learners work together, use relevant methods to develop knowledge and skills, and learners are encouraged to play an active role in science classroom. Teachers view teaching as telling but learners have difficulties understanding the meaning of NS concepts. Lack of parental support from home in learning of science makes learning a two-way process between learners and teachers to be very slow.

Findings from qualitative data from senior phase HoDs and grade 7 NS learners corroborate relevant teaching methods that encourage learners to play active role in science learning with the view of teaching as telling but rendering difficult the understanding of NS concepts. Findings concurred that teachers make use of inquiry in teaching to challenge learners. There is a lack of resources like relevant books, science kits and many things that are useful which decreases the learner's confidence. The findings confirmed that learners memorised without understanding science concepts.

4.5 RESULTS ON STRATEGIES EMPLOYED BY TEACHERS TO ASSIST LEARNERS IN LEARNING NS CONCEPTS

The previous section looked at learner-centred strategies that are utilised in the teaching and learning of NS concepts, as well as responses to the questionnaire. This section presents results on strategies employed by teachers to assist learners in learning Natural sciences concepts as the third research question. Quantitative results are presented followed by qualitative results on the same issue. Summary of the findings is then made by analysing common matters coming from both qualitative and quantitative sections of the study, in line with the mixed-methods approach followed.

Table 4.11: Teachers views on strategies employed by teachers assist learners in learning natural sciences concepts *key: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD)*

CHALLENGE FACE BY LEARNERS	**SA** **4**	**A** **3**	**D** **2**	**SD** **1**	**TOTAL**	**Mean**	**SD**
English language foundation contributes to challenges in science learning	20 (31.3)	38 (59.4)	2 (3.1)	4 (6.3)	64	3.17	0.72
Learners can follow scientific instructions	5 (7.8)	14 (21.9)	40 (62.5)	5 (7.8)	64	2.30	0.73
Learners have challenges of lack of prior knowledge	11	40	9	4	64	2.91	0.75
	(17.2)	(62.5)	(14.1)	(6.3)			
Challenge of switching from one language of teaching and learning to another	18 (28.1)	38 (59.4	8 (12.5)	0	64	3.16	0.62

The influence of English on interaction in the science classroom	26 (40.6)	33 (51.6)	5 (7.8)	0	64	3.33	0.62
Challenges in having adequate interpersonal communication skills	5 (7.8)	31 (48.4)	26 (40.6)	2 (3.1)	64	2.61	0.68
Challenges in the use of English science classroom	17 (26.6)	41 (64.1)	6 (9.4)	0	64	3.17	0.58

On the view that English language foundation contributed to challenges in science learning, most of the teacher respondents 58(90.6%) confirmed by agreeing that indeed the issue of English foundation contributed to challenges in science learning. On the contrary, only a small minority of the teacher respondents 6(9.4%) disagreed with the view. This shows that the issue of English language foundation was considered as a challenge in science teaching and learning. With a mean of 3.17, it further shows that the average response to this question item was on the agreement side.

On whether learners can follow scientific instructions, most teacher respondents 45(70.3%) disagreed with few teacher respondents 19(29.7%) agreeing with the view. This shows that the learners could not follow the scientific instructions. With a mean score of 2.30, that means the regular response to this question item was on disagreement side.

On learners' challenges regarded lack of prior knowledge, most of the teacher respondents 51(79.7%) confirmed by agreeing while only a small minority of the teacher respondents 13(20.4%) disagreed with the view. This shows that the issue of learners lacking prior knowledge was considered as a challenge in science teaching and learning. With a mean of 2.91, it further shows that the average response to this question item was on the agreement side.

Regarding the challenge of switching from one language of teaching and learning to another, most of the teacher respondents 56(87.5%) confirmed by agreeing that there was such a challenge, whereas a small minority of the teacher respondents 8(12.5%) disagreed with the view. This shows that the issue of switching from one language of teaching and learning to another was considered as a challenge in science teaching and learning. With a mean of 3.16, it further shows that the average response to this question item was on the agreement side.

On the view that English influenced interaction in the science classroom, most of the teacher respondents 59(92.2%) agreed with only a small minority of the teacher respondents 5(7.8%) disagreeing with the view. This shows that the issue of the influence of English on interaction in the science classroom, was considered as a challenge in science teaching and learning. With a mean of 3.33, it further shows that the average response to this question item was on the agreement side.

On the challenges of having adequate interpersonal communication skills, many teacher respondents 36(56.2%) confirmed by agreeing that learners lacked interpersonal communication skills and 28(43.7%) disagreed with the view. This shows that the issue of having adequate interpersonal communication skills was considered as a challenge. With a mean of 2.61, it further shows that the average response to this question item was on the agreement side.

On the competence in the use of English science classroom there are challenges faced by learners based on NS concepts. Most of the teacher respondents 58(90.7%) confirmed the challenges faced by learners based on NS concepts learning. On the contrary, only a small minority of the teacher respondents 6(9.4%) disagreed with the view. This shows that the issue of the use of English in science classroom was a challenge in science teaching and learning. With a mean of 3.17, it further shows that the average response to this question item was on the agreement side.

Table 4.12: Learners views on the strategies employed by teachers assist learners in learning natural sciences concepts

Key: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD)

Strategies employed by teachers	SA 1	A 2	D 3	SD 4	TOTAL	MEAN	SD
The teacher improves learner's interest in science.	44 (17.4)	146 (57.7)	56 (22.1)	7 (2.8)	253	2.10	0.70
Science teaching in learning Natural sciences has a strong long-term impact	28 (11.1)	152 (60.1)	72 (28.5)	1 (0.4)	253	2.18	0.62

Teachers encourage more students to study science	57 (22.5)	154 (60.9)	42 (16.6)	0	253	1.94	0.62
Improving aspects of education may be broader or narrower.	26 (10.3)	156 (61.7)	67 (26.5)	4 (1.6)	253	2.19	0.63
Teachers allow all learners to demonstrate more positive patterns in understanding of science concepts and vocabulary.	24 (9.5)	144 (45.9)	85 (33.6)	0	253	2.24	0.61
Teachers involve creativity in terms of teaching and learning of natural sciences concepts	33 (13.0)	155 (61.3)	65 (25.7)	0	253	2.13	0.61
Teachers are science experts.	4 (1.6)	128 (50.6)	108 (42.7)	13 (5.1)	253	2.51	0.62
Teachers answer all the questions asked by learners about what they are teaching.	21 (8.3)	129 (51.0)	94 (37.2)	9 (3.6)	253	2.36	0.68
Teachers explain well what they are teaching	28 (11.1)	141 (55.7)	83 (32.8)	1 (0.4)	253	2.23	0.64
Science concept circle helps the learners to form the conceptual relationships among identified words	8 (3.2)	101 39.9)	131 (51.8)	13 (5.1)	253	2.59	0.64

On whether the teacher improves learners' interest in science, most of the learner respondents 190(75.1%) confirmed by agreeing whereas only a small minority of the learner respondents 64(24.9 %) disagreed with the view. This shows that the issue of the teacher improving a learner's interest in science was considered as not a challenge in science teaching and learning. With a mean of 2.10, it further shows that the average response to this question item was on the agreement side

On science teaching in learning Natural sciences having a strong long-term impact, most of the learner respondents 180(71.2%) agreed with only a small minority of the learner respondents 73(28.9%) disagreeing with the view. This shows that the issue of science teaching in learning Natural sciences has a strong long-term impact. With a mean of 2.18, it further shows that the average response to this question item was on the agreement side.

On whether it was possible that teachers encouraged more students to study science, most of the learner respondents 211(83.4%) agreed while 42(16.6%) disagreed with the view. This shows that the issue of teachers encouraging more students to study science was considered a challenge in science teaching and learning. With a mean of 1.94, it further shows that the average response to this question item was on the agreement side

In response to the view that improving aspects of education may be broader or narrower, most of the learner respondents 182(72%) responded in the affirmative unlike 71(28.1%) who disagreed with the view. This shows that the issue of improving aspects of education being broader or narrower was considered a challenge in science teaching and learning. With a mean of 2.19, it further shows that the average response to this question item was on the agreement side

In terms of teachers allowing all learners to demonstrate more positive patterns in understanding of science concepts and vocabulary, most of the learner respondents 168(55.4%) confirmed while only a small minority of the learner respondents 85(33.6%) disagreed with the view. This shows that the issue of teachers allowing all learners to demonstrate more positive patterns in understanding of science concepts and vocabulary was considered a challenge in science teaching and learning. With a mean of 2.24, it further shows that the average response to this question item was on the agreement side.

On the view that teachers involved creativity in terms of teaching and learning of Natural sciences concepts, most of the learner respondents 188(74.3%) agreed with 65(25.7%) learner respondents disagreeing with the view. This shows that the issue of teachers involving creativity in terms of teaching and learning of Natural sciences concepts was considered a challenge in science teaching and learning. With a mean of 2.13, it further shows that the average response to this question item was on the agreement side

On the view that teachers are science expert, most of the learner respondents 132(52.2%) agreed but a small minority of the learner respondents 111(47.8%) disagreed with the view. This shows that the issue of teachers being science experts was considered as a solution in science teaching and learning. With a mean of 2.51, it further shows that the average response to this question item was on the agreement side
Learners indicated trust that teachers answered all the questions asked by learners about what they were teaching, as confirmed by most of the learner respondents 150(59.3%) and opposed by only a small minority of the learner respondents 103(40.8%) who disagreed with the view. This shows that the issue of teacher answering all the questions asked by learners about what he or she was teaching was considered, without doubt, as

a challenge in science teaching and learning. With a mean of 2.36 it further shows that the average response to this question item was on the agreement side

Tteachers explained well what they were teaching, most of the learner respondents 169(66.8%) agreed while 84(33.2%) disagreed with the view. This shows that the issue of teacher explaining well what he or she was teaching was considered a challenge in science teaching and learning. With a mean of 2.23, it further shows that the average response to this question item was on the agreement side.

Learners did not all share the view that science concept circles helped the learners to form the conceptual relationships among identified words, with most of the learner respondents 144(56.9%) disagreeing with the view, and fewer of the learner respondents 109(43.1%) agreeing. . This shows that the issue of science concept circle helping the learners to form the conceptual relationships among identified words not considered, as a challenge in science teaching and learning. With a mean of 2.59, it further shows that the average response to this question item was on the disagreement side.

4.5.1 Qualitative results on strategies employed by teachers assist learners in learning NS concepts

The main theme on strategies employed by teachers in teaching NS concepts generated other sub-themes which included, instructional strategies by teachers, assessment strategies commonly used by teachers, qualified NS teachers and availability of NS teachers Table 4.13 presents the main theme and sub-themes which are further elaborated in the following sections

Table 4.13: Theme and sub-themes on strategies employed by teachers assist learners

Theme	Sub-themes	Related issues
Strategies employed by teachers in teaching NS concepts	Instructional strategies employed by teachers (code-switching)	Teachers use both isiXhosa and English when they are teaching. teachers acknowledge where they are struggling with English language

		teachers were quietly aware about LiEP code-switching encourage and motivate learners to learn
	Assessment strategies commonly used by teachers	Assessment cannot be divorced from the teaching and learning. Strategies used are homework, groupwork, assignments, projects, tests, etc.
	Qualified NS teachers	Teachers are qualified as professional teachers for any learning area or subject, not specifically as NS teacher.
	Available training of NS teachers	Lack of training is associated with the frequency of problems experienced in the classroom. Teachers have learnt on their own most of the time. Teachers are in dire need of more formal training, especially practical training.

4.5.1.1 Instructional strategies employed by teachers (code-switching

The language policy encourages the code-switching during teaching and learning. The researcher also used code-switching for participants to understand the research questions. Code-switching is a strategy that was used by teachers for NS teaching and the HoDs and focus group interviewees responded on the question asked strategies employed by teachers assist learners in learning NS concepts under sub-theme of instructional strategies employed by teachers:

Learners cannot comprehend the English language, and this affects the teaching and learning of NS. (H4)

Teachers do their best they even break meanings into their level of understanding. (H1)

I switch between languages (use more than one language) to help the learners to learn the NS concepts in English and understand the content of the subject, and, group discussions. (H6)

Focus groups said that:

Some of the teachers write what is on the textbook forgetting that we do not understand the meaning of the NS concepts. (FG3)

The only suitable strategy for us as learners is to code switch but we are aware that there are words that only stand in English. (FG8)

In this question, as learners to be fully accommodated in teaching and learning of NS by allowing isiXhosa as a language of teaching and learning. (FG7)

Code-switching could be the right device used to enable learners to use their main language for thinking, discussion and a resource for teaching and learning. (FG6)

Whatever the aim, the truth is that the common thing for educators was to use codeswitching to simplify learning of NS concepts. Code-switching is the strategy used in the situation of this sub theme for effective learning attention must be given when using language that accommodate isiXhosa learners. This means that learners are, in effect, taught bilingually. Teachers need to be confident in the learner’s home language. The researcher was of the opinion that while code-switching was an effective method of introducing English second language learners to NS concepts, it was of no help in progressing into the conceptual domain if the educators themselves were unsure of this strategy.

4.5.1.2 Assessment strategies commonly used by teachers

The researcher's intention was to investigate the assessment strategies used by teachers in teaching NS concepts. All the schools, HoDs were quite clear about what the concepts involved. When requested to give their understanding of assessment strategies used by teachers, HoDs mentioned how they used assessment to encourage learners to perform to the best of their abilities, using different assessment strategies:

So, when we do our prep, even when we draw up activities, we make sure that we use simple English to accommodate our learners because we know them that they may not get the answers even if they know because of the language. (H5)

As much as we lack the material, but we make sure that we use the books that have the pictures so that even if the learners did not have an idea, they may see the picture. (H7)

And we do a lot of revision. We're just doing revision to prepare them even if they don't understand the meanings. Most of the time we … give them another opportunity to improve their mark. (H1)

It was clear from the responses that assessment was where teachers got to know the learner's performance and the quality of their learning. It took place during the process of teaching and learning to support, assist and diagnose the learner's strengths and weaknesses.

4.5.1.3 Qualified NS teachers

The HoDs referred to their own teaching experience as important when asked about their qualification in teaching NS.

During the allocation of duties, I was allocated to teach NS without looking at any qualification. (H3)

It is the personal issue to answer about how or when I qualify to teach NS (H8)

All the HoD respondents showed discomfort when asked about their qualifications specifically NS subject. They just referred to their teaching experience and training years. They supervised INTERSEN (Intermediate and Senior phase) whereas grade 7 is only the last class in primary school.

Learners' sentence of teachers was understandable at such an early age as they may be impressionistic about the educators' qualifications. All the focus groups came out with the *"we do not know who is qualified or not"*

4.5.1.4 Available training of NS teachers

In response to whether workshop attendance had improved their expertise in teaching of NS concepts, three of eight HoDs indicated that it had not, while five of eight of the agreed that workshop attendance could improve the expertise in teaching. A teacher's level of education and training may develop their approach to teaching and learning of NS. The effect of the attendance of workshops on the performance of NS was determined through interviews. Responses by participants were:

I am an HoD and a possible deputy principal at my school since I am acting in the position. I do attend content and methodology workshops that are available for NS, so I think the information from the workshop is sufficient to help me with the subject. (H8)

I make sure that I attend any NS workshop available, use as many resources to prepare for my lesson, and I ask for help when I need it. (H5)

The responses of the HoDs indicated that teachers viewed workshop attendance as a contribution factor to improving NS performance.

Some of the HoD participants showed a negative attitude when asked if there were any trainings or workshops that could help with NS teaching:

I did not attend any NS workshop and the only thing I used to attend is a moderation where the subject advisors just moderate the work, we already have without doing the 'how to teach' workshop. (H1)

It was clear from the HoDs that there was a lack of training and workshop attendance.

4.5.2 Main findings on strategies employed by teachers assist learners in learning natural sciences concepts

Responses were given to both quantitative and qualitative questions to establish the strategies employed by teachers to assist learners in learning NS concepts. It was also commonly noted that teachers involve creativity in terms of teaching and learning of NS concepts. On the focus of the study, which is the teaching of NS concepts to English second language learners, teachers and learners had different views on strategies employed by teachers when teaching. The following table, Table 4.14, presents the main findings on strategies employed by teachers to assist learners in learning Natural sciences concepts.

Table 4.14: Triangulation table of findings from quantitative and qualitative data

Findings (Quantitative data)	**Findings (Qualitative data)**
English language contributes to a challenge in science learning, learners cannot follow the scientific instruction.	Teachers presented scientific instruction in isolation without considering the meaning of science concepts.
Subject related factors that influence challenges of code-switching from language of teaching and learning to home language (isiXhosa).	Confirmed about the challenge that makes the teachers end up code-switching all the time.
Learners form the theoretical relationship among the identified words in teaching NS concepts.	Practical work helps learners to make and identify words in teaching NS concepts.
Teachers encourage the learners to learn the scientific subjects.	Confirmed that as much as teachers encourage learners to learn scientific subjects but learners explain things more easily when used their home language(isiXhosa).

Table 4.14 presents a summary of both quantitative and qualitative findings on strategies employed by teachers to assist learners in learning natural sciences concepts.

4.5.2.1 Interpreting the triangulation table

Quantitative data established that there are strategies employed by teachers to assist learners in learning NS concepts. HoDs admitted that they needed professional development in approaches, and the focus group interview with learners indicated that they could benefit from a change in teachers' approaches. English language is a challenge in science learning, as some learners cannot follow the scientific instruction. There was a challenge of code-switching from language of teaching and learning to home language (isiXhosa). Teachers were to be creative to develop learners' abilities in understanding science concepts and processes, and to ensure learners formed the theoretical relationship among the identified words in teaching NS concepts. Teachers encouraged the learners to learn the scientific subjects.

From qualitative data, teachers presented scientific instruction in isolation without considering the meaning of science concepts. Both groups of respondents confirmed the challenge that made the teachers end up code-switching all the time. Support offered by teachers to learners was practical work when e-learning software and mixing into subjects takes place to make and identify words in teaching NS concepts. As much as teachers encouraged learners to learn scientific subjects, learners explained things more easily using their home language(isiXhosa).

4.6 RESULTS ON CHALLENGES TEACHERS AND LEARNERS ENCOUNTER IN THE TEACHING AND LEARNING OF SCIENCE CONCEPTS

The findings in the previous section confirmed that there were strategies employed by teachers to assist learners in learning Natural sciences concepts. However, further investigations by the researcher revealed that there were also challenges teachers and learners encountered in the teaching and learning of science concepts. Quantitative and qualitative data was gathered to answer the sub-research question; what challenges do teachers and learners encounter in the teaching and learning of science concepts? These results are presented in both the qualitative and quantitative data form. This section presents results of teachers' and learners' views on challenges teachers and learners encounter in the teaching and learning of science concepts.

Table 4.15: Teachers views on challenges teachers encounter in the teaching and learning of science concepts

Key: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD)

CHALLENGES IN THE TEACHING AND LEARNING OF NS CONCEPTS	SA 4	A 3	D 2	SD 1	TOTAL	MEAN	SD
Teachers and learners encounter challenges in the teaching and learning of science concepts	24 (37.5)	36 (56.3)	4 (6.3)	0	64	3.31	0.59
There are attitudinal problems toward learning and teaching of NS	16 (25.0)	39 (60.9)	9 (14.1)	0	64	3.11	0.62
Students easily understand all the concepts, words and contents given in the NS textbooks.	1 (1.6)	6 (9.4)	28 (43.8)	29 (45.3)	64	1.67	0.71
Learning and teaching in primary schools enable students to be confident in their learning.	6 (9.4)	27 (42.2)	24 (37.5)	7 (10.9)	64	2.50	0.82
Teaching and learning through one's own language in primary school limits students' understanding and knowledge.	11 (17.2)	19 (29.7)	22 (34.4)	12 (18.8)	64	2.45	0.99
Engagement of learners in practical activities at school for natural sciences	8 (12.5)	44 (68.8)	10 (15.6)	2 (3.1)	64	2.91	0.63
Teachers have sufficient opportunity to attend seminars and workshops to improve their science teaching	5 (7.8)	32 (50.0)	25 (39.1)	2 (3.1)	64	2.63	0.68

On the view that teachers and learners encounter challenges in the teaching and learning of science concepts, most of the teacher respondents 60(93.8%) agreed with only few of teacher respondents 4(6.3%) disagreeing with the view. This shows that the issue of teachers and learners encountering challenges in the teaching and learning of science concepts was considered as a challenge in science teaching and learning. With a mean of 3.31, it further shows that the average response to this question item was on the agreement side.

On the view that there were attitudinal problems towards learning and teaching of NS, most of the teacher respondents 55(85.9%) responded in the affirmative, whereas only a small minority of the teacher respondents 9(14.1%) disagreed with the view. This shows that the issue of attitudinal problems toward learning and teaching of NS was considered as a challenge in science teaching and learning. With a mean of 3.11, it further shows that the average response to this question item was on the agreement side.

On the view that students easily understand all the concepts, words and content given in the NS textbooks, most of the teacher respondents 57(89.1%) disagreed with only 7(11%) teacher respondents agreeing with the view. This shows that the issue of understanding all the concepts, words and content given in the NS textbooks was considered as a challenge in the teaching and learning of ns concepts. With a mean of 1.67, it further shows that the average response to this question item was on the disagreement side.

On the view that learning and teaching in primary schools enables students to be confident, the teacher respondents were divided because 33(51.6%) agreed and 31(48.4%) disagreed, and there was not much difference between the teacher respondents. This shows that the issue of enabling students to be confident in their learning was considered as a division between the teachers in science teaching and learning. Mean of 2.50 further shows not much difference between the teacher respondents.

On the view that teaching and learning through one's own language in primary school limits students' understanding and knowledge, few of the teacher respondents 30(46.9%) agreed with many of the teacher respondents 34(53.1%) disagreeing with the view. This shows that the issue of teaching and learning through one's own language in primary school limits students' understanding and knowledge and needs to be considered as a challenge in science teaching and learning of NS concepts. A mean of 2.45 further shows that the average response to this question was on the disagreement side.

On the view that engagement in practical activities at school for Natural sciences contributed to challenges in science learning, most of the teacher respondents 52(81.3%) agreed, but on the contrary, only a small minority of the teacher respondents 12(18.7%) disagreed with the view. This shows that the issue of engagement in practical activities was considered as a challenge in science teaching and learning. With a mean of 2.91, it further shows that the average response to this question item was on the agreement side.

On the view that teachers have sufficient opportunity to attend seminars and workshops to improve their science teaching, most of the teacher respondents 37(57.8%) agreed and 27(42.2) teacher respondents disagreed. This shows that the issue of teachers having sufficient opportunity to attend seminars and workshops to improve their science teaching needs to be considered as a challenge in science teaching and learning. Even when we look at a mean of 2.63, it further shows that the average response needed to be noted.

Table 4.16: Learners' views on the challenges encountered by learners in teaching and learning of Natural sciences concepts

Key: All the time (AT), Most of the time (MT), Sometimes (S), Not Often (NO), Never (N)

Challenges encountered by learners in teaching and learning of science concepts	AT 1	MT 2	S 3	NO 4	N 5	TOTAL	MEAN	SD
It is difficult for learners to understand the new Natural sciences concepts when the teacher explains in English.	112 (44.3)	72 (28.5)	64 (25.3)	5 (2.0)	0	253	1.85	0.87
Learners explore how the language of instruction influences the teaching of natural sciences concepts.	62 (24.5)	96 (37.9)	83 (32.8)	7 (2.8)	5 (2.0)	253	2.20	0.91
Language is very important to improve the quality of science education.	130 (51.4)	90 (35.6)	26 (10.3)	7 (2.8)	0	253	1.64	0.78
Learners become adept at codeswitching in challenges they encounter.	43 (17.0)	134 (53.0)	67 (26.5)	9 (3.6)	0	253	2.17	0.74
Learners struggle with the formation of Science concepts.	49 (19.4)	97 (38.3)	101 (39.9)	6 (2.4)	0	253	2.25	0.79
There are problems experienced by learners when they use English as a language of teaching Science.	50 (19.8)	129 (51.0)	66 (26.1)	8 (3.2)	0	253	2.13	0.76
English LoLT influences the performance of learners in science teaching.	76 (30.0)	94 (37.2)	59 (23.3)	21 (8.3)	3 (1.2)	253	2.13	0.98

In response to the view that it is difficult for learners to understand the new Natural sciences concepts when the teacher explains in English, most of the learner respondents 248(98.1%) confirmed while a few minority learner respondents 5(2%) disagreed with the view. This shows that the vies that it is difficult for learners to understand the new Natural sciences concepts when the teacher explains in English was considered a big challenge in science teaching and learning. With a mean of 1.85, it further shows that the average response to this question item was on the agreement side.

On the view that learners explore how the language of instruction influences the teaching of Natural sciences concepts, most of the learner respondents 241(95.2) agreed with an 'all the time' response, with only a small minority of the learner respondents 12(4.8%) disagreeing with a 'not often' response. This shows that the issue of learners exploring how the language of instruction influences the teaching of Natural sciences concepts was considered, without doubt, as a challenge encountered by learners in teaching and learning of science concepts. With a mean of 2.20, it further shows that the average response to this question item was on the agreement side.

On the view that language is very important to improve the quality of science education, most of the learner respondents 146(97.3%) confirmed that all of the time the issue of language is very important to improve the quality of science education, and only a small minority of the learner respondents 7(2.8%) disagreed with a 'most often' response to the view. This shows that the issue of language being very important to improve the quality of science education was considered as a challenge in science teaching and learning. With a mean of 1.64, it further shows that the average response to this question item was on the agreement side.

Learners affirmed the view that learners become adept at code-switching in the challenges they encounter, most of the learner respondents 244(96.5%) confirmed by agreeing that all the time indeed the issue of learners become adept at code-switching in challenge they encounter. On the contrary, only a small minority of the learner respondents 9(3.6%) disagreed with a 'not often' response to the view. This shows that the issue of learners becoming adept at code-switching was a challenge they encountered learning of natural sciences concepts was considered as a challenge in science teaching and learning. With a mean of 2.17, it further shows that the average response to this item was on the agreement side.

With regards to the view that learners struggle with the formation of science concepts, most of the learner respondents 247(97.6%) confirmed with an 'all the time' response that learners struggled with the formation of science concepts. On the contrary, only 6(2.4%) learner respondents disagreed with a 'not often' response to the view. This shows that the issue of learners struggling with the formation of science concepts was considered as a challenge encountered by learners in teaching and learning of science concepts. With a mean of 2.25, it further shows that the average response to this question item was on the agreement side.

In line with the view that there are problems experienced by learners when they use English as a language of teaching science, most of the learner respondents 245(96.9%) agreed with an 'all the time' response with only 8(3.2%) learner respondents disagreeing with a 'not often' response to the view. This shows that the issue of problems experienced by learners when they use English as a language of teaching science was considered as challenges encountered by learners in teaching and learning of science concepts. With a mean of 2.13, it further shows that the average response to this question item was on the agreement side.

On the issue of English as LoLT influence on the performance of learners in science teaching, most of the learner respondents 229(90.5%) agreed with a 'most of the time' response and only 24(9.5%) learner respondents disagreed with the view. This shows that the issue of English LoLT influencing the performance of learners in science teaching was considered as a challenge in science teaching and learning. With a mean of 2.13, it further shows that the average response to this question item was on the agreement side.

4.6.1 Qualitative results on challenges teachers and learners encounter in the teaching and learning of science concepts

The main theme on challenges teachers and learners encountered in teaching NS concepts generated other sub-themes which included, resources in teaching and learning of NS, learners' background, English as LoLT and time allocation for NS. Table 4.17 presents the main theme and sub-themes which are further elaborated in the following sections.

Table 4-17: Theme and sub-themes on challenges teachers and learners encounter in the teaching and learning of science concepts

Theme	Sub- themes	Regarded issues
Challenges encountered by teachers and learners in NS concepts	Resources regarding teaching and learning NS concepts	No laboratories in all the research schools. Most of the textbooks used do not outline the objectives of the NS processes
	Learners background	Learners were from poor backgrounds where parents are not working and those who were working were on private
		institutions worked by themselves.
	English as LoLT	Education policy allows schools to select their own language of teaching and learning. Fluency in English is the most crucial factor in learning science. Language policy was developed to promote multilingualism.
	Time allocation for NS	There is insufficient time prescribed by the policy for NS as a subject.

This section presents information on participants' responses on challenges encountered in the teaching and learning of NS.

4.6.1.1 Resources for teaching and learning of NS

Resources are important in teaching as inspires learning and enables learners to concentrate better. On the issue of resources in the teaching and learning of NS, participants raised that lack of resources as a challenge that hindered the proper and meaningful teaching of the subject. The lack of basic resources remains a problem and continues to compromise teachers' efforts at curriculum innovation in our schools.

There is insufficient teaching and learning material of NS due to substantial number of learners and lack of laboratories in our locations (H2).

Lack of proper infrastructure such as classrooms, laboratories and libraries negatively affected teaching and learning (H8)

We don't have a lab and our classrooms are too crowded with learners and this affects our teaching. (H6)

We do not have adequate materials such as apparatus and science kits. Children learn science without ever touching a microscope. (H7)

Yes, non-availability of resources sometimes affects teaching and learning strategies. Some models and analogies do drive the points home. (H3)

Learners also confirmed infrastructural challenges, and similar views were shared by educators:

Science lessons take place in the classroom since there are no science laboratories. (FG8)

Words which are similar, or pairs of words bring us confusion. Learning a concept requires contrasting the term with other terms within classes (FG5)

Teaching and learning of NS becomes a physical challenge in a situation where basic requirements such as textbooks, science apparatus and equipment are not available. The researcher could assume from these responses that the issue of resources was related to the issue of teaching and learning of NS concepts.

4.6 1.2 Learners' background

The family background of a learner plays a very important role in the learner's learning process. Family background includes factors such as socioeconomic status, two-parent versus single parent household, divorce, family size and neighbourhood. There are many challenges learners faced based on their backgrounds, that affected the teaching and learning of NS. All the HoDs commented on learners' poor background.

This situation can be noted when we want the parents to sign school documents or when the parents are called for the learner performance. We wait for weeks. (H1)

Generally, learners come from different families. You would find that some learners don't have parents, and it becomes difficult for them in the classroom. (H3)

Unfortunately, it is very difficult to find out since learners don't just open about their personal lives. It takes a lot of time to discover such learners. Some learners don't have parents, while others are usually neglected by their parents. (H3)

Hod responses were provided which pointed that learners experience the challenge in their background that affect their NS concept learning. As HoDs mentioned, the majority of learners come to school just as they are without any support of their parents.

4.6.1.3 English as Language of learning and teaching (LoLT)

Although respondents in this study were science teachers and learners, they recognize that NS concepts questions comes in scientific words which require learners to read and understand**.** The research participants showed that English LoLT influenced the performance of learners in science teaching. The HODs expressed the view that teaching NS concepts using English as a LoLT disadvantaged the learners academically, and that it was not in the learners' best interest to do subjects**.**

The language used for teaching is not understandable to most learners and this makes it difficult for them to understand examinations questions because teachers are not expected to explain anything to learners during examination period. Learners commented:

Yes, significant transformation among English and science teaching. Science has difficult words which may be the same word in English but mean different things in NS, and this sometimes confuses us. (FG4)

Yes. NS has bombastic words you cannot even find in a dictionary but must try to understand them because it seems as if we live in science world. (FG3)

Most of the time it demotes the dignity of us as learners because NS bring big words that are too difficult to understand. (FG6)

Science is one of the important learning areas we think the problem is the way or language of teaching and learning practical apparatus. (FG8)

Teachers' lack of proficiency in LoLT is a contributory factor to the effective learning and teaching of Science subjects. For effective teaching of Sciences, it is important that teachers be empowered with skills to teach in both English and the learners' home language (isiXhosa), since many of those teachers lack proficiency in the second language.

4.6.1.4 Time allocation for NS

Time allocation for NS is done in a realistic manner for grades 7-9 (CAPS 2011:9). On the question about the challenges do teachers and learners encounter in the teaching and learning of science concepts under the sub-theme time allocation for NS. Emerging responses were as follows:

No, because practical activities need a lot of time, some research and experiments must be carried out at specific places outside the school premises (H7)

No, there is a lot of work and little time allocated. (H5)

Learners' responses in focus group interviews also related with the HoDs' responses as they stated that a big load of work covered in a period and an unfinished syllabus led to learners' deficient performance.

Because we are learners, we are not sure how to calculate the periods per day, per week. We just heard from our teachers when doing things very fast. (FG8)

Language issue, time allocation, number of learners in one class, grouping of learning areas according to the carriers (FG6)

Teachers do not have enough time for teaching NS concepts. More time needs to be allocated to NS subjects. The participants in this present study expressed concern that teaching IsiXhosa learners in a First additional language becomes an even greater challenge.

4.6.2 Main findings on challenges teachers and learners encounter in the teaching and learning of science concepts

HoDs in this study worked as teachers and as managers, and the challenges teachers and learners encounter in the teaching and learning of science concepts affect everyone at school. School administration, teachers and learners have their separate ways of dealing with the challenges teachers and learners encountered. The following table, Table 4.18 presents challenges teachers and learners encounter in the teaching and learning of science concepts.

Table 4.18: Triangulation table of findings from quantitative and qualitative data

Findings (Quantitative data)	Findings (Qualitative data)
Teachers and learners encountered challenge in teaching and learning of science concepts. It is difficult for learners to understand NS concepts when explained in English.	Affirmed that teachers and learners encountered challenges and difficulties to understand NS concepts.
Learners develop an attitude towards teaching and learning of NS because they become adapted at code-switching.	Confirmed the attitude towards teaching and learning of NS and the struggle with the formation of science concepts,
Learners do not understand the science concepts, words and content given in the NS textbooks,	Problems experienced by learners when they use English as a language of teaching science.
Teachers have sufficient opportunity to attend seminars and workshops to improve science teaching.	Agreed on the issue of teachers having sufficient opportunity to attend seminars and workshops not being enough.

Table 4.18 presents a summary of both quantitative and qualitative findings on challenges teachers and learners encounter in the teaching and learning of science concepts

4.6.2.1 Interpreting the triangulation table

The results from quantitative data established that there were challenges teachers and learners encountered in the teaching and learning of science concepts. HoDs confirmed that it was difficult for learners to understand NS concepts when explained in English that means the issue of language of learning is continuing because the respondents mentioned English language as a reason that made the learners not cope. They confirmed that acceptable code-switching made the learners to be more adapted.They further asserted that learners do not understand the science concepts, words and content given in the NS textbooks. They also indicated that teachers had sufficient opportunity to attend seminars and workshops to improve science teaching and learning.

Responses from qualitative data confirmed that teachers and learners encountered challenges and difficulties in understanding NS concepts. It is a challenge for teachers to connect science concepts and understand that for every concept taught. Teachers established the attitude towards teaching and learning of NS and the struggle with the formation of science concepts continues. The participants bemoaned problems experienced by learners when they use English as a language of learning science. Teachers observed that poor working conditions hindered their commitment. Co-operating, teachers' role and effort on the issue of teachers have insufficient opportunity to attend seminars and workshops is not enough. The respondents confirmed that resources were inadequate and that there was poor teamwork in the teaching of NS.

4.7 RESULTS ON IMPLICATIONS FOR SCIENCE EDUCATION

Effective implication of science education could be affected by challenges. The teaching of NS concepts to English second language learners has implication for science education. Learners tend to develop negative attitudes towards the language of learning due to affective tendencies and wayward behaviour that is symptomatic of people of low selfesteem. Also, qualitative and quantitative data was meant to answer the sub research question; what are the implications for science education?

Table 4.19 presents results on teachers' and learners' views on implications for science education.

Table 4.19: Teachers views on implications for science education

Key: Always (A), Regular (R), sometimes (S), Never (N)

IMPLICATIONS FOR SCIENCE EDUCATION	A 4	R 3	S 2	N 1	TOTAL	MEAN	SD
English LoLT influences the performance of learners in Science learning area.	0	30 46.9	19 29.7	15 23.4	64	2.23	0.81
Teachers experience problems when using English as a language of teaching Science.	2 3.1	33 51.6	16 25.0	13 20.3	64	2.38	0.84
Code-switching is an approach used in Natural sciences Classrooms.	0	17 26.6	24 37.5	23 35.9	64	1.91	0.79

Learners struggle with the formation of Science concepts.	0	35 54.7	25 39.1	4 6.3	64	2.48	0.62
Teachers' understandings of Natural sciences influence their ability to implement a transformational curriculum	10 15.6	20 31.3	31 48.4	3 4.7	64	2.58	0.81
Support received from school when implementing or teaching Natural Science in English.	6 9.4	29 45.3	12 18.8	17 26.6	64	2.39	0.98
English LoLT is a barrier to Science learning.	5	36	15	8	64	2.59	0.81
	7.8	56.3	23.4	12.5			

On the view that English LoLT influences the performance of learners in Science learning, most of the teacher respondents 49(90.6%) agreed with an 'always' compared to only a small minority of the teacher respondents 15(9.4%) who disagreed with a 'never' to the view. This shows that the issue of English LoLT influence the performance of learners in Science learning area was considered as a challenge in science teaching and learning. With a mean of 2.23, it further shows that the average response to this question item was on the agreement side.

In proportion to the view that teachers experience problems when using English as a language of teaching Science, most of the teacher respondents 51(79.7%) affirmed with an 'always' an a small minority of the teacher respondents 13(20.3%) disagreed with a 'never' to the view. This shows that the issue of teachers experiencing problems when using English as a language of teaching Science was considered as a challenge in science teaching and learning. With a mean of 2.38, it further shows that the average response to this question item was on the agreement side.

In line with view that code-switching is an approach used in Natural sciences Classrooms, most of the teacher respondents 41(64.1%) confirmed with an 'always' response and only a small minority of the teacher respondents 23(35.9%) disagreed with the view. This shows that the issue of code-switching as an approach used in Natural sciences classrooms was considered as a challenge in science teaching and learning. With a mean of 1.91, it further shows that the average response to this question was on the agreement side.

With regards to the view that learners struggle with the formation of Science concepts, most of the teacher respondents 60(93.8%) agreed with an ‘always’ response, with only a few teacher respondents 4(6.3%) disagreeing with a ‘never’ response. This shows that the issue of learners struggling with the formation of Science concepts was considered as a challenge in science teaching and learning. With a mean of 2.48, it further shows that the average response to this question item was on the agreement side.

Regarding the view that teachers’ understanding of Natural sciences influence their ability to implement a transformational curriculum, most of the teacher respondents 61(95.3%) agreed with an ‘always’, contrary to 3(4.7%) teacher respondents disagreeing with a ‘never’ to the view. This shows that the issue of teachers’ understanding of Natural sciences influencing their ability to implement a transformational curriculum was considered a challenge in science teaching and learning. With a mean of 2.58, it further shows that the average response to this question item was on the agreement side.

About science education support received from school when implementing or teaching natural sciences in English curriculum, most of the teacher respondents 47(73.5%) agreed with an ‘always’ response as opposed to 17(26.5%) who disagreed with a ‘never’ response to the view. This shows that the issue of support received from school when implementing or teaching natural sciences in English curriculum was considered a challenge in science teaching and learning. With a mean of 2.39, it further shows that the average response to this item was on the agreement side.

Nearby the view that English LoLT is a barrier to Science learning, most of the teacher respondents 56(87.5%) confirmed with an ‘always’ response to the issue of English LoLT being a barrier to Science learning compared to 8(12.5%) who disagreed with the view. This shows that the issue of English LoLT being a barrier to science learning was considered a challenge. With a mean of 2.59, it further shows that the average response to this question item was on the agreement side.

Table 4.20: Learners' views on the implications for science education

Key: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD)

IMPLICATIONS FOR SCIENCE EDUCATION	SA 1	A 2	D 3	SD 4	TOTAL	MEAN	SD
Learning science is beneficial to learners.	120 (47.4)	129 (51.0)	4 (1.6)	0	253	1.54	0.53
Learners have limited academic language proficiency.	57 (22.5)	150 (59.3)	42 (16.6)	4 (1.6)	253	1.97	0.67
Learners lack understanding of English academic language.	60 (23.7)	145 (57.3)	46 (18.2)	2 (0.8)	253	1.96	0.67
Learners fail and under achieve due to use of a language which is not their home language or mother tongue.	49 (19.4)	150 (59.3)	50 (19.8)	4 (1.6)	253	2.04	0.67
The curriculum is focused on preparing students for studying science.	57 (22.5)	133 (52.6)	56 (22.1)	7 (2.8)	253	2.05	0.75
English home language helps to understand scientific terms.	71 (28.1)	140 (55.3)	41 (16.2)	1 (0.4)	253	1.89	0.67
Learners do not benefit much when learning science in English.	49 (19.4)	164 (64.8)	40 (15.8)	0	253	1.96	0.59

On the view that learning science is beneficial to learners, most of the learner respondents 249(98.4%) agreed with very few of the learner respondents 4(1.6%) disagreeing with the view. This shows that the issue of learning science being beneficial to learners was considered as a challenge in science education. With a mean of 1.54, it further shows that the average response to this item was on the agreement side.

Regarding the view that learners have limited academic language proficiency, most of the learner respondents 207(81.8%) responded in the affirmative whereas on the contrary 46(18.2%) disagreed with the view. This shows that the issue of learners having limited academic language proficiency was considered as a challenge in science teaching and learning. With a mean of 1.97, it further shows that the average response to this question item was on the agreement side.

Concerning about learners lacked understanding of English academic language, most of the learner respondents 205(81.8%) agreed with a minority of the learner respondents 46(18.2%) disagreeing with the view. This shows that the issue of learner's lack understanding of English academic language was considered as a challenge in science education. With a mean of 1.97, it further shows that the average response to this item was on the agreement side.

Another view was that learners fail and underachieve due to use of a language which is not their home language or mother tongue. To that view, most of the learner respondents 199(78.7%) agreed, while a minority of the learner respondents 54(21.4%) disagreed with the view. This shows that the issue of learners failing and under achieving due to use of a language which is not their home language or mother tongue was considered a challenge in science teaching and learning. With a mean of 2.04, it further shows that the average response to this question item was on the agreement side.

In line with the view that the curriculum is focused on preparing students for studying science, most of the learner respondents 190(75.1%) confirmed the view, with only a small minority of the learner respondents 64(24.9%) disagreeing with the view. This shows that the issue of the curriculum is focused on preparing students for study science was considered, without doubt, as a challenge in the implications for science education. With a mean of 2.05, it further shows that the average response to this question item was on the agreement side.

In proportion to the view that English home language helps to understand scientific terms, most of the learner respondents 211(83.4%) agreed but by contrast, a small minority of the learner respondents 42(16.6%) disagreed with the view. This shows that the issue of English home language helping to understand scientific terms was considered a challenge in science teaching and learning. With a mean of 1.89, it further shows that the average response to this item was on the agreement side.

To the view that learners do not benefit much when learning science in English, most of the learner respondents 213(84.2%) agreed but 40(15.8%) learner respondents disagreed with the view. This shows that the issue of learners not benefitting much when learning science in English was considered a challenge in science teaching and learning. With a mean of 1.96, it further shows that the average response to this question item was on the agreement side.

4.7.1 Qualitative results on implications for science education

The main theme on implications for science education generated other sub-themes which included education policy concerning NS, school administration role in teaching and learning of NS, role of CAPS document in teaching and learning of NS, and parental involvement on teaching and learning of NS. Table 4.21 presents the main theme and subthemes which are further elaborated in the following sections.

Table 4.21: Theme and sub-themes on implications for science education

Theme	**Sub- themes**	**Required issues**
Implications for science education	education policy concerning NS	The policy that is used on teaching and learning of NS is national policy document. Teachers do act in compliance with policy provision.
	school administration role In teaching and learning of NS	Language used during teaching and learning NS. Curriculum based on NS teaching.
	role of CAPS document in teaching and learning of NS	Teachers focused on policy document for teaching and learning. CAPS clarifies the requirement of what to be taught in each subject.

	parental involvement in teaching and learning of NS	Involvement of parents improves the academic achievement of a learner. Parents did not get adequate support from the parents. Parents are untrained and not know how to help their children.

4.7.1.1 Education policy concerning NS

In response to the question on the policy that is used on teaching and learning of NS, HoD participants indicated that the documents were available in the schools. The responses were:

Policy is very important in every subject, we cannot teach any subject without policy and we follow the policy when we teach. (H4)

We use CAPS document during teaching and learning of NS concepts (H6)

Every learning area uses policy document that guide the teacher to teach. (H8)

NS policy used in teaching and learning makes the subject more difficult for learners to understand the subject because it is in line with LoLT. (H3)

All the focus group participants mentioned that they did not even know how the teachers used the policies. They made it clear that they did not understand anything based on policies or the way teacher did on their planning.

4.7.1.2 School administration role on teaching and learning of NS

On the responsibility the school administrators and governors had to develop the teaching and learning of NS, participants specified the need to build laboratories and other resources.

We need to get funding to construct a laboratories in our schools so that learners can experience real learning of science. (H1)

The department must deliver and *organise enough teaching and learning materials like books, laboratory, science kit. (H3)*

Learners focus group interviews also had the same views as phase HoDs:

Department must organise resources and they must build a specialist room for science teaching and learning so that learners would be safe during NS teaching. (FG3)

It was clear from the participants that school administrators and governors had a huge role to play in providing infrastructure and material resources to enhance the teaching of NS.

4.7.1.3 Role of CAPS document in teaching and learning of NS

When requested to give their understanding of the role of CAPS document in teaching and learning of NS, all the participants had a shared idea that the CAPS document has an influence on the teaching and learning of NS concepts. All the HoDs were quite articulate about what the document entails, although they could not link their descriptions. One school HoD gave a comprehensive description thus:

Policies are designed by the department of education and are delivered as a pack for teachers just to implement them without any teacher involvement. I think we as teachers, we just do or use what we have been given without complaining. (H1)

I think the most important thing is to read the CAPS document which directs the fundamental principles derived before planning of NS lessons. (H2)

Usually, with the CAPS textbooks, it is a bit easy because they have what we call a 'word bank' in the learner's books. (H8)

7 of the HoDs said:

It is much difficult to teach science, because there are no recourses in our school, and then we must refer to the text book only. We try to have pictures in the classroom, like charts so that at least there are some referrals.

This means that the role of CAPS document in teaching and learning of NS is important, without even comparing with the old syllabus. The document specified the tasks in the curriculum for assessment and guided the teachers to give clear guidance to the assessment.

4.7.1.4 Parental involvement in teaching and learning of NS

Interview participants were asked what parents do to enhance the teaching and learning of NS in the school. The responses indicated that parents were so scarce in the learners' work, which increased the learners not being serious in their work. Teachers reported that they were trying to call for meetings, but parents did not attend because of their working commitments. However, they confirmed the importance of knowing learner academic and social backgrounds. All the HoDs concurred that parental involvement can increase learner pass rate. One of the schools HoDs mentioned that:

No, most of the parents did not have formal education so they cannot help their children in doing their school work and some do not provide time for learner to do work after school. (H4)

Other responses from the HoDs described the parents as not involved in the teaching and learning of NS. However, they defined parental involvement as imperfect and meaningless because most of the parents are uneducated, cannot read and write, and they do not even understand their role in their children's education. There was also a shared consensus among participants that learners can perform well if they can see their parent working together with school activities positively involved in school. It can lead to them having a positive attitude towards the subject, as indicated below:

Yes, but there is no much support because our parents are working, and they were not too much involved in our studies, but they encourage us to read our books. (FG3)

Our parents are not involved in teaching and learning, and sometimes our parents do not want to attend the class meetings. It can take time because we think that parents need workshops so that they must be positively involved in our teaching and learning. (FG7)

Parents were unable to assist us with school science homework because they did not study science at school, and because the syllabus was no longer the same. (FG1)

Parental involvement in teaching and learning plays a key role in children's academic performance. It was also indicated that the lack of parental involvement is caused by different perceptions of parental involvement, and by the attitude the parents towards learners and teachers.

4.7.2 Main findings on the implications for science education

Research results have shown that teachers and learners faced a challenge with science education when using English as LoLT. Table 4.22 presents the main findings on implications for science education from quantitative and qualitative data.

Table 4.22: Triangulation table of findings from quantitative and qualitative data

Findings (Quantitative data)	Findings (Qualitative data)
Teachers experience problems when using English as a LoLT while learners have limited academic proficiency.	Claims that the role that needs to be played by the school when using language of teaching and learning NS concepts.
Teachers' understanding of NS influence the ability to implement a transformational curriculum whereas learners do not benefit much when learning science in English.	Teachers were not well trained in the curriculum, and learners would continue to struggle in the learning of complex subjects like Science in English.
There is support received from school when implementing or teaching NS in English curriculum.	Natural sciences curriculum should be enhanced to promote scientific literacy in learners. All the stake holders involved must play a role.
Policies are designed by the department of education without teacher involvement.	Noted the design policies of the department of education. The
	implementation of policies without being thought through, resources fail and cause a tension between expectation and delivery.

4.7.2.1 Interpreting the triangulation table

The results from quantitative data revealed that there are implications for science education. Results confirmed that all the township schools' teachers used the English language as a medium of instruction in the classroom whereas teachers experienced problems when using English as a LoLT and learners had limited academic proficiency. The low level of English on the part of the learners makes it difficult for the teachers to communicate freely and use English effectively to teach science. Teachers' understanding of NS influence the ability to implement the transformational curriculum, but learners did not benefit much when learning science in English. The challenge was not limited to NS teachers only. Rather, it was a challenge for most teachers in the primary schools. The participants indicated that school administrators and governors needed to play a role, to ensure the provision of laboratories and all other required material resources necessary for the meaningful teaching and learning of NS. That is why there was support received from school when implementing or teaching NS in English curriculum. They reiterated that policies were designed by the department of education without teacher involvement.

Responses from qualitative data affirmed the role that needs to be played by the school when using language of teaching and learning. The CAPS document specified the need to use the policy document to teach the learners. Although they used the policy documents, some were not clear about its contents; and needed the district officials to unpack it. Teachers were not trained well in the curriculum and learners would continue to struggle in the learning of complex subjects like Science in English. The participants argued the mediators of implementing policies without questioning its quality, that the relevance and importance accept as true situations about successful learning for learners on the teaching of NS concepts. Natural sciences curriculum should be enhanced to promote scientific literacy in learners. All the stakeholders involved must play a role. Participants noted the design policies of the department of education. The implementation of policies without being thought through fails and causes tension between expectation and delivery.

4.8 DISCUSSION OF THE RESEARCH FINDINGS THEMATICALLY

This study sought to examine the teaching and learning of Natural Sciences concepts involving English second language learners in selected primary schools in East London education district. In this section, the research findings are discussed in the light of the themes drawn from the sub-research questions that guided the study. The discussion focuses on findings generated from descriptive statistics (frequencies, means and standard deviations), inferential statistics, and qualitative data from open opened questions and interviews. The discussion is done with reference to literature, both from local and international settings.

4.8.1 How teachers link the teaching of NS concepts to learners' prior knowledge

The first research question of the study looked at how teachers linked the teaching of NS concepts with learners' prior knowledge. Learners should answer questions and ask questions relating to the lesson to ensure that they understand the taught concepts. Learners who learnt science, not in their first language, faced the problem of understanding both the scientific terminologies (technical terms) and regular explanation of the content itself (Maznah & Zurida, 2006). Learner participation and being actively involved is one of the characteristics of a learner-centred teaching approach, as learners bring some prior knowledge to the lesson, upon which they construct new understanding. The curriculum in a specific learning area is structured in such a way that the knowledge and skills set out in the learning activities builds up from the construction of basic concepts to more differentiated experiences, as they progress from one grade to another. This finding was confirmed by both teachers and learners from questionnaires and HoDs interviews. Responses gave an impression that the teachers linked the learner's prior knowledge to new knowledge when teaching NS concepts. In terms of strategies for developing learners' knowledge, the suggested learning activities generally over emphasised the importance of finding out information from learners, and teachers required that cooperative learning methods be used. This allowed learners to learn from each other, develop communication skills, make use of the prior knowledge, and develop existing knowledge. Subjects are no longer taught in isolation. Instead, there is integration. No piece of knowledge exists in isolation. It is all linked to a bigger system and every system consists of several parts that work together in order to function as a whole (Higgs & Smith 2006:27). In constructivist approaches to teaching, learners' prior knowledge is considered important as the starting point for the construction of new knowledge, and prior knowledge and experiences are determined by culture and social context (Chisholm & Leyendecker, 2008).

Accommodating learners' prior knowledge and different learning rates makes leaners to be confident. Moreover, most of the respondents reported that they encouraged learners to express their thoughts and ideas. They did this for self-evaluation and criticism. Encouraging learners to express their thoughts and ideas assist an educator to find out learners' interest in his or her lesson and make it possible for educators to give guidance. This way, learners feel they are part and parcel of the lesson. Teachers linked language to achievement and acknowledged that learners' competence in the language of instruction affected their performance at school. They admitted that learners with English as a home language performed better than learners with English as an additional language, and the less that additional language learners are immersed in English, the poorer their performance (Fleisch, 2008).

4.8.1.2 English second language learners

Learners who use English as LoLT do not have good results in science subjects than in the other learners that were taught English as home language have demonstrated higher results in science subjects. This may be the reason that learners do not understand teachers when teaching NS concepts because NS is taught in English. While learners that use English as home language and it’s much easier for them to grasp on the NS concepts. They appear to be lacking awareness of links between their science activities and the language they use. Although science education is now recognised as being important for all throughout their compulsory schooling, it is hard to shake off the traditional image. Learners taught English as home language are at a higher advantage of passing the NS concepts as they have proper demonstration and laboratory equipment in their schools. Learners that use English as second language are disadvantaged as teachers do not have proper infrastructure and only depends on the theory to make the learners understand the science.

4.8.1.3 Understanding of scientific principles

The scientific principles involvement is currently implemented and influence learner's language skills. Such a way that the improvement is irregular and affects the learners' skill in their home language. Learners' focus group in this study appeared to feel more comfortable when communicating in their mother tongue in the classroom, but that English is the Language of Learning and Teaching of choice in these schools, it is possible that the Scientific principles approach combined with carefully formulated code-switching strategies could enhance both learning of science and learners' general knowledge.

Harmer (2009) points out that there are many occasions when using the students' L1 in the classroom has obvious advantages. The learners of the focus groups indicated that teachers used a variety of strategies in NS teaching.

4.8.1.4 Factors affecting teaching and learning of NS

The finding for the factors affecting teaching and learning of NS concepts was that teachers compartmentalise their knowledge of the learning area and cannot access information or build connections between the knowledge and teaching. In addition, teaching strategies that formed the core of a lesson impacted learner understanding. In a related study, Ferreira (2011) found that learners did not only experience challenges with English as a language, but also with scientific language. The same view is shared by Schaffer (2007) who says that science lessons taught in English are language lessons as they involve learning both science and the language. This shows the major challenges that could be faced by primary school learners learning science.

4.8.1.5 Language used during teaching and learning of NS

Teachers see English as a barrier to learning as learners do not perform to the best of their ability due to a lack of understanding. This creates a barrier for learners when they engage with concepts and understanding of knowledge at elevated levels of competence. Learners preferred that their home language be used alongside the language of learning and teaching (English). They revealed that they were not confident to read, write, speak and follow instructions In science learning, in English. Learning science through a medium other than the home language is a challenge to any learner, no matter how intelligent.

Understanding the NS concepts needed the use of the learner's first language in teaching and learning to provide the support needed, while the learners continued to develop proficiency in the language of learning and teaching. Webb (2010) notes that "using a language that is not the learners' home language compels educators to use teachercentered methods of instruction which include chorus teaching, repetition, memorisation, and recall. This probably contributes to the lower performance in the Science subject when English is used to teach Science.

4.8.2 Learner-centred strategies utilised in the teaching and learning of NS concepts

The second sub-research question for the study explored the learner-centred strategies utilised in the teaching and learning of NS concepts. The support was expected from grade 7 NS learners, teachers and senior phase HoDs on behalf of school management team (SMT). Findings from questionnaires and interviews revealed that the strategy of placing learners at the centre when teaching was innovative. According to CAPS, (2011) the involvement of learners in a lesson is important to optimise learning. The main idea is to involve learners during the learning process as opposed to having the teacher dominating the whole learning process, with learners playing an inactive role as if the teacher is a source of knowledge and learners are empty containers that need to be filled in with information. In South Africa, the National Curriculum and Assessment Policy Statement CAPS (2012) for Natural sciences Grade 7-9 is based on, among other things, the principles like active and critical learning, which encourage an active and critical approach to learning, rather than rote and uncritical learning of given facts. This shows that the South African education as highlighted by CAPS (2012) documents, according to the Department of Education (2011), requires learners to take a focal point in their own learning in class.

4.8.2.1 SMT involvement

All the respondents were positive that learners must be involved when teaching and learning NS concepts. All the teachers involved the learners during teaching and learning of NS. However, the Department of Basic Education (2013) highlighted that most HoDs and teachers in schools were computer illiterate. As a result, HoDs could not manage to use computers to implement NS concepts and enhance more engaging learner centred methods that are only possible using computers as a medium of instruction in classrooms.

It can then be said that computer illiteracy on the part of the teachers was problematic in the implementation of the learner centred methods. For example, if the Natural sciences teacher wants to present information about volcanoes in video, audio and text, he/she may only succeed to do so if he/she uses a PowerPoint projector connected to the laptop or computer. If the teacher is computer illiterate, he/she cannot manage to plan for, and go on to execute such a lesson.

4.8.2.2 Different teaching approach

The study found that teachers were aware of different teaching and learning approaches but mostly employed the telling method. Educator participants admitted to using the text book method, group work, experiments, and investigations, but to not using other methods due to lack of resources. However, one educator admitted that he needed professional development in approaches, and the focus group interview with learners indicated that they could benefit from a change in teachers' approaches. Prior studies from the National Science Education Standards (National Research Council, 1996) indicate that an understanding of the nature of scientific inquiry is an important goal of science education. The same issue is raised by Dudu (2014) who points out that inquiry approaches in science enable teachers to be creative and enrich students' abilities in understanding science concepts and processes. Dudu further underscores the importance of employing the appropriate teaching methods in science to develop scientific literacy among learners by engaging learners in scientific inquiry for them to develop broad knowledge and understandings of the processes and nature of science. Effective teaching methods that match the learners' needs allow them to identify strategies to assist the learners with special needs.

4.8.2.3 Planning and structuring of NS teaching

An interpretation of the evidence generated from the data shows the teachers' understanding of what the expectations of the curriculum are in terms of planning, and the decision-making processes that they engage in as they visualise the future and develop a framework that guides their future actions. In conclusion, the main factors that influence the teachers' planning decisions and the enactment of these lesson plans in the classroom are reflected upon. HoDs mentioned that lesson plans are written out on a weekly basis, describing the topic, learners' activities, resources, references and assessment tasks. The plans are written on a standard template that teachers obtain from the Policy Guideline document. Plans may differ, but the details remain basically the same. A lesson plan can be written out for a day, a week or two, or to cover a specific topic, and they are kept in the teacher's file. Planning procedure is the most important phase in designing the learner centred approach programme, because all other phases are dependent upon the data which is collected at this stage. The purpose of planning and structuring is to ensure that the teacher follows the timetable in terms of the content of NS concepts that is taught, and that the correct pace is maintained. HoDs mentioned that teachers did not manage to complete all the activities as planned, and they overlapped till the year ends. This shows that at the end of that year, learners wrote a formal assessment test without finishing the syllabus. Nkabinde (2012) observes that HoDs are responsible for the planning and organisation of their departments to ensure that departmental subjects are taught effectively and efficiently.

4.8.2.4 Learner involvement

Learners are involved during the teaching and learning of NS and learn by doing. This leads to creativity and innovation on the side of learners. Johnson and Christensen (2008) note that learner centred teaching methods expose learners to different mathematical and scientific problems to solve individually or as a group. That means allowing learners to share ideas and learn from each other motivates them to be eager to learn and to continue learning more. Learner involvement enables learners to grasp NS concepts better, because learners learn better from whereas the findings in this study shows that learners find some difficulties because of their environment and when participate during teaching and learning process. Another finding that the researcher picked in learner involvement is that the strategy of using learners as a resource during teaching NS is beneficial according to the participants' views because it enables learners to take full responsibility of their own learning and education. Participants also mentioned that the learner-centred approach is an important teaching strategy in education, that prepares learners for independent maturity roles when they finally graduate from school into communities.

4.8.3 Strategies employed by teachers assist learners in learning NS concepts

The study results significantly brought to light several viable and sustainable strategies employed by teachers to assist learners in learning NS concepts**.** Code-switching was one such strategy. Code-switching and mixing is advantageous because it facilitates teaching and learning through the language that both teachers and learners understand. The use of regular code-switching, however, has some disadvantages because it does not encourage the learners to use English appropriately to improve their communicative competence. In the following section, the findings focus on science learning, and they emerge from the interactions between teachers and learners from the teaching and learning process. Benson (2009), states that the benefits of HL education are well documented and demonstrated by several studies, among which, The Six Year Yoruba Primary Project yielded the most meaningful results regarding the education of second language learners

4.8.3.1 Instructional and assessment strategies by teachers (code-switching)

Teachers mentioned that terminology was the most common struggle, especially in lower grades, in the sense that the learners do not understand the English terms that are being used in science lessons since the learners are taught using second additional language. Teachers struggle, especially in the foundation and senior phase, to teach science in the home language mainly due to the fact that they themselves are not fully competent with that language in terms of all the scientific vocabulary that they need to use to explain the concepts to the learners. Wababa, (2009) investigated teaching and learning support materials in classes and studied the roles of English and isiXhosa in mediating cognitively challenging subject content, particularly Natural sciences concepts and terminology. This indicates that the teachers' lack of proficiency in the language contributes to how NS should and can be taught. Teachers decide to code switch into isiXhosa as it is the best possible language of explaining certain topics, in their context. Teachers assumed that learners had a much better understanding of the topic if they employed code-switching. From the overall response of the teachers, one could establish that language was causing severe limitations in the ways in which teachers taught science. Teachers tend to teach learners to formulate patterns of learning by creating prompt strategies. This approach promotes rote learning more than understanding of scientific concepts. Teachers use code-switching to clarify a point, and it is imperative that the teacher reverts to LoLT so that leaners do not lose the focus on English in the science lesson.

4.8.3.2 Lack of qualified NS teachers

The HoD respondents highlighted that shortages of qualified NS teachers. In this study the participants show that teachers just teach NS without qualifying if they have the teaching experience because of the shortage of the teachers that trained specifically for science subjects. They asserted that inadequate staffing resulted in high teacher-learner ratio. Although results revealed discord in perception on whether teaching was a profession, there was clarity of opinion that circumstances in teaching could be re-engineered to facilitate teacher conduct. According to Lebata (2014), the science subjects need a lot of passion and dedication from the teachers as they should take their time in guiding learners through challenging concepts of science which they should make interesting. Findings revealed workshops on the development of NS concepts knowledge and on practical investigations as the professional development needs of NS teachers to realise effective teaching of NS.

4.8.3.3 Availability of training

The results of the study also confirmed claims by Moodley (2010) that the teachers were not adequately trained in respect of the new curriculum. These left teachers confused and demotivated, because implementing a new curriculum requires thorough training about the effective methods to disseminate information to learners effectively. The study findings showed that the lack of specialised subject content in educators caused poor learner performance during teaching and learning of NS concepts. Teachers who participated in this study mentioned that they were not specialised in teaching NS subjects but were just trained as professional teachers. Since NS in lower grades is clustered as NS and Technology, that posed difficulties. Although quantitative data identified teaching as a profession, this could not be supported by qualitative submissions. It turned out that respondents failed to justify the conviction that teaching was indeed, a profession, as many such respondents failed to identify characteristics which defined a profession.

4.8.4 Challenges teachers encounter in the teaching and learning of science concepts

Teacher and learner responses from questionnaires indicated that there are challenges teachers encounter in the teaching and learning of science concepts. The challenges included, lack of resources for teaching and learning of NS concepts, poor student background, use of English as language of teaching and learning (LoLT), and little time allocation for NS as a subject. It was in Grade 7 Natural Sciences where the researcher personally noticed the challenges experienced by learners concerning the grasp of science concepts due to the lack of command of the language of teaching and learning. This study found out that second language learners studying Science in English faced a dual task, that of learning the language in which Science is taught and, simultaneously learning Science related content. This study explored the issues of language and how it influenced Natural sciences teaching and learning as experienced in the researcher's school and the surrounding schools. Tan and Tan (2008) underscore the challenges of learning in a second language, which results in learners' failure to interpret the meaning of Mathematics and Science concepts.

A better command of the language of teaching and learning is essential to participate in the various fields of the sciences. If learners do not understand the building blocks of the language they use, then they may be highly challenged in comprehending scientific concepts. Studies by Rost, (2001) corroborate the study by Harrison and Krol (2007), which assessed English second language learners and the challenges faced with linguistic transfer of phonological processing. To improve performance of learners in schools' parents and children must be involved in the curriculum development process. This assertion by Gardner (2009) who called for the abandonment of the teacher centred curriculum and an introduction of a healthier and creative learner centred curriculum.

4.8.4.1 Resources regarding teaching and learning of NS concepts

Both qualitative and quantitative data shows that there is a lack of resources for teaching and learning of NS concepts. All schools lack resources and that affects the progress of the learners. They argued that in school's resources were not adequate for the implementation of the learner centred teaching methods in NS classes. Shortage of materials and apparatus, as well as poorly equipped NS laboratories are some of the major challenges that inhibit the proper implementation or use of learner centred teaching methods in NS classes. Respondents mentioned that classes were too large, and resources scarce, such that it became difficult for teachers to determine and fulfil the unique needs of different learners in class. Heugh (2009) confirms the shortages of resources even in the schools abroad by saying, “Even if you go to the universities you will find that there are very limited bursaries to promote African languages and also there are no language policies to encourage students to learn African languages”.

Teachers ended up improvising or explaining concepts theoretically due to the shortage of resources needed for practical experiments. NS teachers needed facilities and resources for teaching and learning, which include classrooms, science laboratories, laboratory equipment and apparatus, libraries and computer laboratories, to save time for teaching and learning.

4.8.4.2 Student background

The study found that deprived learners, and village background negatively affected the teaching and learning of NS. The data collected showed that the background affected the teaching and learning of Natural sciences in schools. Most of the learners who participated in this study came from under-privileged homes. Research by Chinyoka and Naidu (2014) also shows that poor homes are usually overcrowded, with the same sexes sharing a room. This can result in the learners not having adequate space to study or to do their homework or interact with their peers at home in relation to school work. The learners often can only afford the basic schooling material and nothing more. The learners do not get help from their parents, nor can their parents afford tutors for extra lessons when they struggle. The only chance they have for learning is at school, which is of limited hours. Reddy (2004), who coordinates the study of science and mathematics in South Africa, explained that there is multiple factors that contribute to learners’ deficient performance. The participants showed much concern for the poor background that affects teaching and learning in the township schools.

4.8.4.3 English as Language of Learning and Teaching (LoLT)

Teachers strongly agreed that the challenge of using English as Language of Learning and Teaching is visible during teaching and learning of NS subjects. This was earlier observed by Adler, et al. (2002). The challenge is that of the negative impact of English on the cognitive development of English second language learners on scientific subjects. The findings with teachers and learners revealed that English as language of teaching and learning is a barrier to the teaching and learning of NS for learners who are not first language speakers of English, and who have a poor English background. All the students came from township schools and their background was from rural communities and they were staying with their parents who came to work in the city. Those learners did not understand English in its simplest form. When such learners were taught in English, they did not learn at all. Worse still, the learners were not able to express their understanding challenges because they could not express themselves in the LoLT. Exams and tests were written using both English and science languages, and during assessment no code-switching was done. This disadvantaged the learners because they would not understand the questions nor be able to express themselves efficiently. At the same time, teachers did not feel comfortable using code-switching in teaching because the examinations would be written in English only. Science is a subject that requires one to grasp the concepts and be able to communicate them in writing. Therefore, a lack of proficiency in English also results in the learners being unable to communicate their ideas (Hlabane, 2014, Setati, 2011).

4.8.4.4 Time allocation for NS

The teachers viewed time as being vital to teaching science lessons that are beneficial to the learner. The teachers stated that science concepts needed more time to be explained. However, the learners complained that they needed more time to grasp all the information. This simply meant that one hour per day was not enough to teach all the abstract science knowledge. Successful learning is determined by the ability of the working memory to process additional information and to store it in schemas so that more space can be made available for additional information (Anthony & Artino, 2008). However, teachers participants in the senior phase (grade 7) mentioned that the amount of time invested in teaching NS is limited, and not much can be done during that time to teach science to the learners. Teachers believe that due to time constraints, whatever the learners do not acquire is taught to them in the next grade. Teachers are overloaded because they, not only teach NS, but also other subjects. The teachers need a lot of time to prepare, and have little time to assist the learners with extra classes. This leaves the teacher overworked because science needs a lot of practice.

4.8.5 Implications for science education

The study findings on the implication of science education portrayed that teachers made use of policy documents to guide their teaching. The CAPS document specified the need to use the policy document to teach the learners effectively. It emerged from the study that teachers used policy documents to guide them when implementing the curriculum. Although they used the policy documents, some were not clear about them, and needed the district officials to unpack them. According the Department of Basic Education (2011), the teaching and learning of NS is explicitly spelt out in the policy document from suggested content areas, aims and objectives to be achieved, time allocation, teaching and learning methods, as well as assessment techniques. However, the teachers should be able to interpret the policy documents correctly in order to ensure effective implementation of the NS curriculum.

4.8.5.1 Education policy concerning NS

The study also has implications for HoDs in schools and NS teachers when dealing with the language content of Natural Sciences This study provides the NS teachers with an understanding of how issues of code-switching could support the learning of science and how this could add value to learners' everyday application of curriculum science. With Curriculum and Assessment Policy Statements (CAPS), comes an Examination Guidelines document that outlines the accepted formulae and definition of terms. The aim of the document is to eliminate to ensure that teachers and learners are scientifically and theoretically correct. A study by Wallace et al. (2004), presents the challenges facing education planners like subject advisers in implementing changes in the syllabi that would result in the elimination of the language problems on the cognitive development of English second language learners. Furthermore, implications of English as a language of learning and teaching (LoLT) in South African schools have a distinctive presence. The policy document for Natural Sciences in the Senior Phase (Grades 7-9) is clear about the content to be taught.

4.8.5.2 Role of CAPS document in teaching and learning of NS

The findings on the role of Curriculum and Assessment Policy Statement (CAPS) document in teaching and learning of NS in schools show that the all schools in this study area used CAPS document, which captures the Department of Education requirements. Schools with district support officials choose to work directly with the NS teachers in providing professional development and/or curriculum support on the CAPS with no similar support for the HoDs specifically. While the HoDs benefit from such support by the district, the benefits relate more to their roles as teachers rather than as subject leaders. The notion of science subjects has emerged largely due to the government's acknowledgement of the role that science plays in economic growth, employment creation, social redress, and social development (Department of Education, 2012)**.**

4.8.5.3 School administration role on teaching and learning of NS

HoDs, NS teachers and learner respondents had different opinions on the role of school administration on teaching and learning of NS. Learners said that teachers offered suitable support when teaching NS concepts. The positive acknowledgement of such kind of support agreed with Alkani's (2014) assertion that teacher support is a key factor in making a difference to the school environments and in promoting enabling learning for students (Zendah, 2017). According to the learner respondents, teachers tried to give support to learners during learning of NS concepts. School administration role in teaching and learning of NS is to plan and oversee NS policy within the schools, while managing curriculum and educational programs. HoDs and teachers mentioned that there is less support from both the school and the department. They revealed that workshops and training activities were scarce, and lack of resources were a challenge in the township schools. School administration should provide NS teachers and HoDs with training and motivate, specifically the English second language learners them in their teaching and learning of NS subjects. Another issue was that both teachers and HoDs were trained to become qualified teachers not specialised subject experts. In addition, NS subject advisors provided support in the form of school visits, which helped both HoDs and NS teachers by providing a form of guidance regarding subject content and checked that teaching and learning is on a write track.

4.8.5.4 Parental involvement

Parental involvement in this study was shown as limited because respondents mentioned that parents only attended parents' meetings without any involvement to their children's school work. They could not assist their children with their school work because they did not understand the. Findings on parental involvement showed that parents shared a common goal with their schools, but their involvement in the schools was limited by factors characterised as characteristics, philosophies and practices of the family see the theory of overlapping spheres (Kgaffe, 2001; Maake, 2014; Makgato & Mji, 2006). This limitation of parental involvement has a negative effect on a learner's education. These findings confirm the findings from previous research which state that poor parents have little or no education meaning they are not involved in their children work and are unable to assist their children with schoolwork (Chinyoka & Naidu, 2014).

4.9 DISCUSSING FINDINGS AGAINST THEORETICAL UNDERPINNINGS OF THE STUDY

The research study sought to examine the teaching of Natural sciences concepts to English second language speakers. In this section, the researcher discusses findings and how this study differs, confirms or adds to literature review and theoretical framework employed in chapter two. The researcher refers to the sub-research questions used in this study and explains what was found in the study. Scientists have looked at the philosophical foundations of different kinds of research and have attempted to identify and classify what different authors refer to as the theoretical underpinnings (Bogdan & Biklen, 2007). The theory used in this study was social constructivism that focuses on the individual learner's conceptual framework. This theory notes that knowledge needs to be intelligible and fruitful for the learner to make sense of it. Social constructivism looks at how learning is influenced by the social environment e.g. interaction between teachers and learners, and among learners themselves.

4.9.1 Linking of NS concepts to learners' prior knowledge

In teaching and curriculum development, it is important to consider and understand learners' prior knowledge and concepts, to determine how teaching should be planned and implemented. In this study, the importance of language in teaching and learning of NS concepts is highlighted. O'Brien (2011) states that to learn science is to learn the language of science, and learners need to be sensitised to the importance of becoming fluent in the foreign language of science. Most Science learners in South Africa have to study the subject in their second or third language. Besides having to understand the language of science, they need to master the medium of instruction. This disadvantages learners to a considerable extent. Setati (2011) states that it is acknowledged that expecting learners to learn a new and difficult subject through the medium of a second language is unreasonable because this gives them a double task of mastering science concepts, content and the language. Learners construct own science knowledge as they try to connect with their own experiences from various sources including the home and the school. Social constructivism are interlinked and are equally important in knowledge construction.

Learners' everyday knowledge develops within the culture and social context within which learners grow up (Chisholm & Leyendecker, 2008; Leach & Scott, 2003). Their ideas are often very different from scientific knowledge. They are alternative conceptions or as Leach and Scott, (2003) suggest, the scientific view is the alternative perspective for the learner. The learners in the eight schools in which the studies took place came from a wide range of backgrounds. It is important for the teacher to explore their prior conceptions about science. Taylor (2008) notes one of the arguments against the use of prior knowledge as a starting point in science as that, it disadvantages working class children who have less access at home to school-linked knowledge than middle class children. Teachers should be able to guide learners to understand the role of science during teaching and learning. Learners should also understand that research in science and conceptualisation are ongoing processes. This entails the understanding of all relevant science concepts, the development of cognitive and psychomotor skills of learners, the ability to facilitate the undertaking of inquiries by learners, understanding the nature of the scientific enterprise and the relationship between science and society, and the development of a sense of personal worth (Chisholm & Leyendecker, 2008; Leach & Scott, 2000).

Matjila and Pretorius (2004) contend that the reason so many learners do not understand what they are learning in NS subjects is that they are not adequately proficient in the language of learning and teaching, which is the language they use when they are learning. Clark and Linder (2006) referring to a teacher's comments during their study in the Western Cape, suggest that with the abolition of NS in schools and students' assertion of their rights, there has been a rearrangement in learner-teacher relationships (Clark & Linder, 2006). Teachers consider learners' varying ability to communicate in English, the language of learning and teaching (LOLT). Learners who have English as an additional language are being inducted into both Science and English as a social practice. They have a double challenge and struggle to understand and acquire new concepts. Lack of fluency in English as LOLT slows down the learning process (Fleisch, 2008). Understanding of the NS concepts requires much support in the learning environment for example learning materials. Textbooks still seem to be one of the most important tools in science learning. Several suggestions made by Duit (2009) advance the notion that teaching, and learning are difficult phenomena for which there is no fast track. The process of theoretical change usually requires various changes of views to open up a whole new conceptual space, and this usually takes time and effort (Duit, 2009; Yore & Treagust, 2006).

4.9.2 Learner- centred strategies utilised in the teaching and learning of NS concepts

Setati (2011) states that learners bring into the science classroom a variety of common sense or views derived from individual experiences of the world. These contribute to the social context of the classroom where learners' own discourses become extended to incorporate scientific discourse. Stone (2007) states that learners are good thinkers when they have a deep understanding of key scientific concepts, and that good scientific thinking means being able to generate questions for inquiry, develop sound hypotheses, design controlled experiments, collect and present appropriate data, use evidence to support a conclusion, and effectively communicate an experimental process. The acquisition of these skills was, not only useful for the mastery of Science subjects, but also useful for learners in future, irrespective of the careers they follow.

In the usage of varied Natural sciences subject teaching methods, according to Sujaya, Suarni, and Candiasa, (2013), teachers need to be aware that not all the subject materials are suitable to be taught using the same instructional model related to the improvement of learners' learning success. It is important to be aware that some learning models can be used by teachers in the instructional process to achieve learning objectives that have been previously defined. Some researchers (Hattingh, 2008; Rogan, 2004) have suggested that the traditional African oral style of teaching, in which rhetoric is highly valued may be a more appropriate way of teaching large classes**.** National Curriculum Statement (2011) stipulates that instructional time for Sciences should be increased to three hours per week. This therefore, requires proper weekly planning to ensure that the time is used optimally. For any teaching situation, it is essential to address clear and appropriate learning goals and objectives, to build concepts and principles in such a way that learners grasp them with ease; to develop skills and to practice dispositions that are valued by the community (Hammerman, 2006). This can be done by effective lesson planning and learning. Muzah (2011) states that literature demonstrates the growing realisation that most learning theories have an excellent value in the organisation of knowledge, have value in the direction of research for new knowledge, are used in the solution of problems, are of importance in understanding how children learn and hence facilitate learning and teaching processes in our daily situation and in classroom. Throughout the lesson planning exercise, it is important to consider the development of process skills of science, critical and creative thinking skills, and dispositions to include and emphasise (Hammerman, 2006). This procedure is relevant for science educators and learners to follow as it would facilitate a more effective and structured science lesson planning and learning effort. Constructivist teaching and learning which suggests a learner-centered approach to science teaching and learning, requires learners to explore learning activities to discover new knowledge.

4.9.3 Strategies employed by teachers assist learners in learning NS concepts

According to Palmer (2007), the methods used must be inventive, encouraging, interesting, beneficial, and provide tools that can be applied to the learners' real life. Some techniques for assuring success are: to state the goals and objectives of the lesson, provide simple and clear explanations, ask the learners to express their comments, ask questions and provide hands-on activities as often as possible. Many researchers believe that employing mother-tongue instruction concurrently with code-switching in a linguistically homogenous class results in better learning and understanding (Probyn, et al., 2002; Setati, et al., 2002).

Muzah (2011) states that educator qualifications together with content knowledge in mathematics and science have become a popular topic in countries such as the United States, Australia, New Zealand, Canada and other countries due to acute shortage of educators in these fields, that has caused retarding success in science. It is important to have specialist science teachers to ensure effective science teaching and learning in schools. Science Community Representing Education (SCORE) (2011) uses ‘specialism’ to refer to the subject knowledge gained by a teacher through their academic and professional qualifications and experience and recommends the use of teachers who are subject specialists. Dudu (2013) and Makgato and Mji (2006) show concern on the lack of qualified science teachers in South African schools.

In terms of training support, teachers lack knowledge and skills regarding the teaching and learning of NS concepts. Department of Basic Education (2013) has committed itself to training and supporting teachers with the use of their ‘Rainbow workbook’ aligned to the current curriculum (CAPS). A teacher's level of education and training may influence the content of, and their approach to, teaching NS. A study across a number of countries revealed that teachers' views on sciences are influenced by their level of education and training, which in turn, tends to reduce religious influences (Berger, et al., 2008). Thus, those with high academic levels (degrees), whether atheist, agnostic, Christian, Muslim or other faiths, all share the same conceptions about the importance of teaching the sciences; biological, social, psychological, affective and relational dimensions. Anastácio, Carvalho and Cléments' research (2008) support these findings.

Primary educators lack the necessary confidence and knowledge of science (Fensham, 2008; Taylor & Vinjevold, 1999) and the anxiety or apathy towards science amongst schoolteachers may be attributed to several key factors. Firstly, teachers who were charged with teaching science due to staff shortages, in many cases did not seek to be specialist educators of science and were trained as generalist teachers (Fensham, 2008). Secondly, many teachers with a background in science finished their pre-service training without having completed aspects of science, which are central to the scientific enterprise, such as investigations (Villanueva & Webb, 2008). Finally, as learners, these very teachers were taught in a traditional, rote fashion. The adage of ‘we teach as we were taught’ suggests that these teachers did not have exposure or role models of effective learner-centred teaching. As a result, the lack of science training and experience in conducting investigations, coupled with the changes to outcomes-based pedagogy, contributes to science teachers who have minimal skills in conducting inquiry-based activities or strategies to promote them (Webb, 2009).

4.9.4 Challenges teachers and learners encounter in the teaching and learning of science concepts.

There are many challenges faced in the teaching and learning of science subjects in schools. National categorisation of schools provides an indication of difference in infrastructure, qualifications of educators, management, governance of schools, educational culture and resource base of schools, and socioeconomic status of learners. Muzah (2011) states that, of the many researchers who looked at factors associated with learners' poor performance in science in South Africa, some agreed on at least the following points: inadequate communication of learners and educators in language of instruction, large classes, lack of qualified science educators, poor teaching methods, inadequate educator knowledge, poor time management, lack of material resources such as textbooks, scientific calculators and laboratory equipment; disruption in class and content coverage, and lack of professional leadership**.** The findings by Ogunniyi (2009) note that a considerable number of teachers experienced difficulties in teaching many of the topics of the Science curriculum depending on their adequate knowledge of the Science content of the curriculum and how often they carry out the practical activities specified in the curriculum.

Various studies cited similar reasons as causes of poor performance in science subjects. Dzana (2012) students fail science due to lack of quality resources, their perception on science subjects as hard, and little time which is allocated to practical lessons. Schools which have textbooks, laboratory equipment and other necessary resources, perform much better than schools which do not have these resources (Cyril & Lucas, 2010). The teachers and learners strongly agreed that if provided with the necessary language of teaching, materials and equipment they require, they would post satisfactory results in science subjects. Findings and the literature identify challenges experienced by learners who receive education in a second language in terms of learners not understanding the LOLT, which produces a language barrier. This language barrier is then viewed as one reason for failing or a lack of progress. Landsberg et al. (2011) and Maake (2014) assert that learners learn best through their mother tongue (home language), and that a second language (English/Afrikaans) is acquired easier if the learner already has a firm grasp of their mother tongue. Building on this viewpoint, OwenSmith (2014) argues that a learner who cannot access education in their home language is disadvantaged and unlikely to be able to perform to the best of their ability and to reach the potential. It is now evident that the language of teaching and learning (LoLT), which is English, is a barrier to effective learning and teaching, especially to the conceptualisation of the intricate science concepts that call for the mastery of the LoLT. Muzah (2011) states that it is believed that the quality of a science educator's teaching and interaction with learners, the process of learning, satisfaction and active learners' participation, decline with an increase in the size of the class.

4.9.5 Implications for science education

Policy initiatives in science and technology teaching ought to facilitate the integration of knowledge systems of all learners (Odora-Hoppers, 2000) in an enabling environment which builds confidence and self-esteem. Policy documents highlight that in terms of time allocation the document cites about the sufficient time that has been provided for teaching, assessment and projects. The content is brief and might need the teacher to be creative in expanding on the content to make sure that learners have a three-dimensional understanding of the content. Fortunately, there was no enough time available for such since the content is rather manageable (Department of Basic Education, 2012). The activities have implications for proficiency in the language of teaching and learning. Learners cannot explore and explain concepts meaningfully if they are using a language in which they lack competence.

The school leadership is responsible for instructional practices and supervision processes, such that the organisation stands or falls on the strength of its leaders. Effective leadership in the school makes a major impact on the calibre of education, promotes effective teaching and learning, which in turn, influences the performance of learners. Muzah (2011) states that school leadership influences the destiny of both educators and learners. Sawyer's (2006) research study supports increased classroom collaboration, and the innovation economy, and demands graduates who are highly skilled at creating together in groups. During interviews, teachers stated the type of teaching strategies they use when teaching NS such as practical examples, pictures and text books. Without good teaching strategies, learners may see teaching as uninteresting and dull, resulting in growing disinterested attitude as their age increase (Prokop, Prokop & Tunnicliffe, 2007). Another study shows that when it was possible to use science apparatus in the classroom, technology could be integrated as substitute (Cherubin, Gash & McClaughlin, 2008).

4.10 CHAPTER SUMMARY

This chapter presented, analysed and discussed the findings from both quantitative and qualitative data. Questionnaires were administered to grade 7 NS teachers and learners, and in-depth interviews were conducted with phase HoDs and grade 7 focus groups. There was document analysis of grade 7 related policy document. The discussion of the findings was done in the context of the sub-research questions posed in Chapter 1, and in relation to local and international literature and to theory. The next chapter presents the summary, conclusion and recommendations of the study.

CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This study sought to examine the teaching of Natural sciences concepts to English second language learners in primary schools. This chapter represents a summary of findings, recommendations made, and suggestions for further studies. The chapter commences with a restatement of research objectives and sub-research questions. This is followed by a summary of key findings based on the quantitative and qualitative responses. The summary findings are followed by the conclusions that were drawn from the presentation and discussion of the findings.

5.2 RESTATEMENT OF THE RESEARCH OBJECTIVES AND RESEARCH QUESTIONS

The study was carried out because of English second language learners' difficulties when they were taught NS concepts. This study revealed that the development of the science curriculum that includes home-grown knowledge accepts excessive confidence for using indigenous technologies as a tool for furthering knowledge development in science and fostering problem solving among the learner. This study sought to examine the teaching of NS concepts.

5.2.1 Research aim and objectives

As reviewed in literature (Marzano, 2009; Thornburg, 2009; Kola, 2013; Muzah, 2011; Ferreira, 2011; Department of Basic Education, 2012; Zisanhi, 2013; Wright & Bilica, 2007) there are challenges in teaching and learning of NS concepts. The use of English as the language of teaching and learning of NS concepts was a factor in slowing the rate of learning in the chosen classes because the learners struggled to communicate in English. Teachers used various strategies for assisting learners to understand the English specifically on the teaching and learning of NS concepts for example the translations and code-switching. The use of English as a language of teaching and learning in these selected township schools, where English was not the home language, affected teaching of NS concepts. This was evident in classes in the townships schools where teachers were trying to teach both concepts and language. The main objective in this study was to examine the teaching and learning of NS concepts to English second language speakers in selected primary schools. The study sought to establish various stakeholders within the

Department of Education. Those responsible for curriculum design would be enabled to design science programmes, which accommodate linguistic challenges faced by second language teachers and learners in the way of teaching NS**.** Senior primary school Science educators, parents and all the stakeholders were expected to be involved and assist in the teaching and learning of NS concepts. Furthermore, the study sought to assess how teachers linked the teaching of Natural sciences concepts to learners' prior knowledge. This was done by considering the learners' prior knowledge. The study also sought to identify challenges teachers and learners encountered in the teaching and learning of science concepts. And fourthly, the study sought to identify learner-centred strategies utilised in the teaching and learning of Natural sciences concepts and ascertain how strategies employed by teachers assisted learners in learning Natural sciences concepts. Finally, the study aimed at establishing implications of science education for teaching of NS concepts.

5.2.2 Main Research Question and Sub-Research Questions

The main research question for this study was; **'**How are Natural sciences concepts taught to English second Language learners in selected primary schools in East London Education District?' This study was guided by five sub-research questions. The first one was, 'How do teachers link the teaching of Natural sciences concepts to learners' prior knowledge?' It was intended to look at what teachers do in order to ensure a link between learners' prior knowledge and new concepts during teaching and learning of NS concepts dealing with the learners that are English second language. The second sub-research question dealt with the learner-centred strategies utilised in the teaching and learning of Natural sciences concepts. Teachers dealt with the strategies applied during teaching and learning of NS concepts. It is important that teachers show the way of teaching skills they use to deal with the attitude learners have in science subjects. The third sub-research question was to identify other strategies employed by teachers to assist learners in learning Natural sciences concepts. The fourth sub-research question related to the challenges teachers and learners encountered in the teaching and learning of science concepts. The last sub-research question was to establish the NS implications for education.

5.3 SUMMARY OF THE FINDINGS

This section presents a summary of the study findings. The summary focuses on teaching and learning of NS concepts to English second language learners and the implication for science education. The summary is given on how teachers linked the teaching of Natural Science concepts to learners' prior knowledge; learner-centred strategies utilised in the teaching and learning of Natural sciences concepts; strategies employed by teachers to assist learners in learning Natural sciences concepts; challenges teachers and learners encountered in the teaching and learning of science concepts and the implications for science education.

5.3.1 How do teachers link the teaching of Natural sciences concepts to learners' prior knowledge?

Learners confirmed that some of the concepts learnt in NS were unfamiliar to them. Science subjects links the classroom situation with real-life. Science needed to make learners aware of the world and the environment and give learners exposure to real-life. Learners' prior knowledge affects, for better or worse, how new information is integrated with NS concepts as well as attitudes towards science in general. This study revealed that if certain learning principles are followed, learners would not be highly challenged in the learning process. Most of the educators accommodated learners' prior knowledge and different learning rates and always encouraged learners to express their thoughts and ideas. However, the use of instructional strategies by educator respondents depended on the type of the lesson. Teachers claimed that Science is a" hands on" practical subject and learners are exposed to multiple opportunities, even when the language barrier is broken. Learners' prior knowledge and experience affects transfer, although sometimes the effect is initially negative as original concepts and routines must be changed to deal with new settings. Without knowledge of learning strategies and ability to fit learners use to the needs of the current situation, learners are unable to make progress. If educators want learners to construct and reflect on their knowledge, ask questions, and plan their own learning, they need to devise assessment strategies that evaluate and encourage these aspects of learning. Prior knowledge ranges from perception to conception, to beliefs about learning itself. The study found that some educators believe that, because they work within a communicative context, new vocabulary words do not have to be formally taught, that learners would understand the meaning of these words from the context and would use them appropriately when needed. By linking these essential instructional strategies with techniques from the field of second-language acquisition, teachers can target the specific needs of language-minority learners.

5.3.2 Learner-centred strategies utilised in the teaching and learning of Natural sciences concepts

The second question asked in this study was whether learner-centred strategies are utilised in the teaching and learning of Natural sciences concepts. It was found that for educators to make meaningful contribution to Science learning, they should adopt a whole language approach for their Science instruction. Some of the distinctive teaching methods of this approach can easily be implemented. Teachers teach science topics using learner-centred approaches in ways that would allow learners to demonstrate the critical and NS learning outcomes at a level appropriate for Grade 7. In addition, teaching NS using learner-centred approaches is a complex skill and depends on teachers' beliefs and more directly on internal and external factors that influence what a teacher is able to do in the classroom.

Teachers' lack of clarity on what it means to teach towards NS concepts was a common problem throughout South Africa according to the task team appointed by the Department of Education to review the National Curriculum and its implementation (Dada, et al., 2009; Fleisch, 2008). Teachers did realise that the 'how' of teaching NS concepts involved learner-centred approaches. Their notions of learner-centred approaches included the learners doing the work themselves, carrying out investigations and having discussions. The use of a language appropriate for the learners who are found in the teachers' classrooms is a learner-centred characteristic, and a critical outcome relates to learners being able to communicate effectively. Learner centred approach denies learners the experience of developing independent thinking skills and strategies for learning. Therefore, educators should be made to understand that the constructivist approach is the more acceptable approach to teaching Science today.

5.3.3 Strategies employed by teachers to assist learners in learning Natural sciences concepts

The study revealed that most of the teachers did not use only English when they delivered NS lessons, but instead, they used both English and isiXhosa. This study found out that second language learners studying Science in English faced a double task, that of learning the language in which Science is taught and, simultaneously, that of learning Science related concepts. The HoDs explained during the interviews that they used both languages in order to facilitate the learning and teaching of NS, since their learners were not competent in English (the LoLT). Teachers extensively used code-switching during teaching and learning. This was in line with the South African LiEP which officially promotes the maintenance of the mother language and access to an additive bilingualism. The extensive use of code-switching by both teachers and learners in the learning and teaching of NS revealed additive bilingualism in the sense that the mother tongue (isiXhosa) of the learner was used as the medium of instruction together with English, the LoLT. In other words, isiXhosa and English were used as dual media of instruction. teachers did not feel comfortable relying on code-switching because the examinations would be written in English only. Some teachers were not sure whether code-switching was officially allowed or not, and so they felt obliged to teach in English, even though they could see that their learners had serious learning challenges through the medium of English. Findings also revealed that the NS educators were assessing learners continuously using a variety of strategies because they were not testing only knowledge but also skills, values and attitudes.

The picture that emerged from the findings was that educator respondents rarely involved parents in the assessment of their learners, but the parents did not take part. Regarding educator professional development, the majority of the educator respondents indicated that they were in need of the professional developments. English is a barrier to the teaching and learning of NS for learners who are not first language speakers of English and who have a poor English background. Teachers said that the majority of learners who came from township communities did not understand English in its simplest form. When such learners were taught in English, they did not learn at all. At the same time, teachers did not feel comfortable relying on code-switching because the examinations would be written in English only. Teachers felt that it was important to teach in English because there was no code-switching in examinations, so learners should be prepared in reading and understanding instructions in English.

5.3.4 Challenges teachers and learners encounter in the teaching and learning of science concepts

Teachers highlighted a number of challenges which inhibited the teaching and learning of NS concepts which included lack of resources, lack of proper infrastructure such as classrooms, laboratories and libraries, as negatively affected teaching and learning.

On the issue of resources in the teaching and learning of NS, participants noted that lack of resources was a challenge that hindered the proper and meaningful teaching of the subject. The lack of resources in township schools placed learners at a considerable disadvantage. Participants also indicated the severe shortage of material resources such as adequate NS textbooks, apparatus, chemicals and other equipment that can be used on teaching of NS. It was, therefore, clear from the participants' insights that learners encountered some challenges in understanding some NS concepts that confront teachers in using approach in their science lesson. Findings from this study showed that problems such large class size, inadequate time and resources, and teachers' prejudice were challenges faced when implementing science lessons. Curriculum demands always give teachers little time to be able to fully and effectively involved for instruction. It was also found that most parents were working. However, minorities of the learners were not living with their parents and hence some of the learners did not get support from home with regard to their academic work.

5.3.5 The implications for science education

The participants indicated that school administrators (HoDs according to this study and governors, department of education) needed to play a role to ensure the provision of laboratories and all other required material resources necessary for the meaningful teaching and learning of NS. Effective HoDs in the school have an effect on the quality of education, promote effective teaching and learning, which in turn, influences the performance of learners. The implication in this study is the use of analysis may be restricted in science lessons and that these issues must be addressed by policy makers and stakeholders of science education if the approach is to be used often. It is equally important for teachers to provide extended lessons on the inquiry approach aimed at addressing problems students encounter as they learn the NS concepts. This would equip them with the needed skills. Curriculum on teaching of NS always gives teachers little time to be able to fully and effectively employ instruction.

5.4 CONCLUSIONS OF THE STUDY

This study sought to explore teaching of Natural sciences concepts to English second language learners in primary schools in the East London education district. The study identified challenges that were encountered by the teachers when teaching NS concepts to the English second language learners which included lack of resources and training. The conclusions in this study are informed by findings and are responsive to sub-research questions set out in this study. The conclusions of this study were drawn from the findings related to the sub-research questions.

5.4.1 How teachers link the teaching of NS concepts to learners' prior knowledge

The language of instruction used for teaching content subjects such as NS is a crucial factor in the academic achievement of learners. Learning NS concepts through the medium of English may create a significant learning barrier for English second language speakers. The teaching and learning process are learner-paced and is not meant to cover the teaching plan. Lessons were built around learners' prior knowledge and all activities were geared towards teaching and learning of NS concepts. The teaching and learning process catered for learners' multiple intelligences and learning styles. The education system produces learners who are responsible citizens. Learners' prior achievement of NS highly influence their choice of science-related subjects and professions. The type of classroom feedback and teacher-learner relationships within science contributed to the learner's expectations.

5.4.2 Learner- centred strategies utilised in the teaching and learning of NS concepts

To achieve both learner-centred and teacher-centred learning, learners can investigate the socio-economic issues which have an impact on NS concepts and can explain the topic and the role of learners. The findings in this study point out the importance of the role played by science teachers in separate phases within the classroom through their teacher learner relationship, teaching and learning as well as the general science curriculum. The study presents a strong indication that science teachers could play a significant role in influencing the number of students opting for NS in Grade 7 and break the stereotype and perceptions that young South African learners have in choosing or not choosing Physical Science as a subject. By organising key concepts or lofty ideas into theme-based units, teachers create extended learning experiences that give learners more time to become proficient with the language used to discuss and explore larger concepts.

5.4.3 Strategies employed by teachers assist learners in learning NS concepts

Learners learn differently and at their own pace. Therefore, teachers use different strategies which provide for different learners in a classroom. During the NS teaching and learning, learners work in groups and peer interaction takes place when doing practical work, such as recording the transactions in the subsidiary books and posting to the ledgers. Classrooms have wall-charts with NS concepts to help learners to internalise learning. The allocation of the scarce resources in the midst of competing priorities might hamper the implementation of a strategy. Lack of shared internal support and the capacities and knowledge of employees to carry out the strategic plan was a challenge. Lack of understanding scientific principles was another challenge of how the strategy must be implemented. Therefore, continuous change of policies and disregard of the existing strategies is a challenge. For example, rushing to complete work seen as compliant can have a negative impact on strategy implementation. As mentioned in chapter 4, many teachers have not been adequately trained and have not been staff-developed so that they can implement the language policies of their respective schools. The strategy teachers used was code-switching, but it is debatable whether the code-switching used by teachers, most of whom were not trained on the use of languages in the teaching of sciences, was effective and really promoted the learning and teaching of the NS subject. Teachers need to plan how they use code-switching, in what situations, and to achieve what objectives.

5.4.4 Challenges teachers encounter in the teaching and learning of science concepts

The study also revealed that NS primary school teachers face several difficulties in teaching NS concepts to the second language learners. These included insufficient teaching resources such as textbooks, elements and components used in the practical activities, lack of computers, shortage of qualified science teachers, and large numbers of learners in the class. Lack of instructional resources hindered the effectiveness of science teachers in implementing continuous assessment. It also appears that there were links between how teachers practiced assessment such as administering tests, homework and practical work; and the availability of instructional resources like textbooks, photocopier and computers. However, this requires further investigation to practice effective continuous assessment. Most of the science teachers indicated that they needed more training on how to prepare and teach NS concepts continuously, including on how to construct tests, projects and practical work. This shows that the preparation of science teachers is crucial in this regard. There is need for the government to have detailed/carefully considered long and short-term plans for the preparation of teachers and continuous professional development through in-service training so that learners fit into the school programme, even if there are language challenges.

5.4.5 Assess the implications for science education

The NS subject advisors should train the teachers who are already teaching NS in educational content knowledge and procedures in NS. Training of teachers should be compulsory for teachers who have been identified through needs analysis that they lack either educational content knowledge or procedures of teaching NS. The implication is that the use of science must be addressed by policy makers and stakeholders if the language approach is to be used often. It is equally important for teachers to provide extended lessons on the NS concepts aimed at addressing problems encountered as they learn the NS concepts. The next section discusses the recommendations for this study.

5.5 RECOMMENDATIONS EMANATING FROM THE STUDY

Based on the findings of this study, the researcher advances the following recommendations meant to improve the teaching of NS concepts to English second language learners:

- Since science is part of learners' everyday lives, the curriculum should make provision for teachers to start their lessons with what learners already know. Teachers also need to have broad knowledge of the learners' everyday experiences in their context.
- Learners’ language in class should be used in teaching concepts in Grade 7 Natural Science. Educators should be familiar with the role of language in the cognitive

development of learners, and with theories of language development and learning and the link between language and learning.

- The Department of Education should put in place the policies that are suitable for teaching and learning using mother tongue instruction. And assist educators financially to improve their teaching and subject content skills in NS by allowing them to undertake short term and long-term professional development programmes.
- Basic resources such as textbooks and science apparatus should also be made available in schools to ensure meaningful teaching and learning of Science.
- Parents sometimes do not become involved in their children's education because they feel they lack academic abilities and hence their involvement is not beneficial to their children's education. The schools should encourage parents to become more involved in parent meetings and teacher conferences, especially at this phase to prepare high school level.
- Learners should be encouraged by their educators to co-operate with NS subject educators and with their peers in the extraction of information which can then be used for classroom discussion.
- Code-switching should be recognised as a resource that may promote the effective learning of science subjects.
- NS teachers need to be developed, trained and equipped with the necessary language skills so that they can improve their teaching of NS. Teacher training institutions should review curriculum timeously to ensure that they are at par with the changes in the educational system and the curriculum.

The way in which the position and roles of a Head of Department (HoD) at a school is designed is such that they are not only responsible for NS, but also for other Sciencerelated subjects, such as Life Sciences and Mathematics. The Department of Basic Education should consider introducing the post of subject heads so that the role of the HODs can be modified so that subject experts are responsible for their subjects of expertise.

5.5.1 Measures to enhance the teaching and learning of NS concepts

The teacher, as the immediate curriculum developer, has a responsibility to use suitable language of instruction to accommodate learners. Attempts to change that motivation are increasingly concentrated on teachers, mostly the way they are trained and how they interact with students. Science standards developed framework for teachers to encourage the learner's enquiry, feed their curiosity, and deepen their understanding of scientific concepts. Teacher-training techniques place a greater emphasis on pedagogy and classroom practice as another way to improve science and technology. Improving outcomes, will require a shift in the classroom from a teacher-centred approach to one that helps learners work through science concepts. Teachers should create projects in which NS concepts become apparent as learners work through real challenges.

This confirmed that the descriptive, interpretive, theoretical and evaluative validity were attended to.

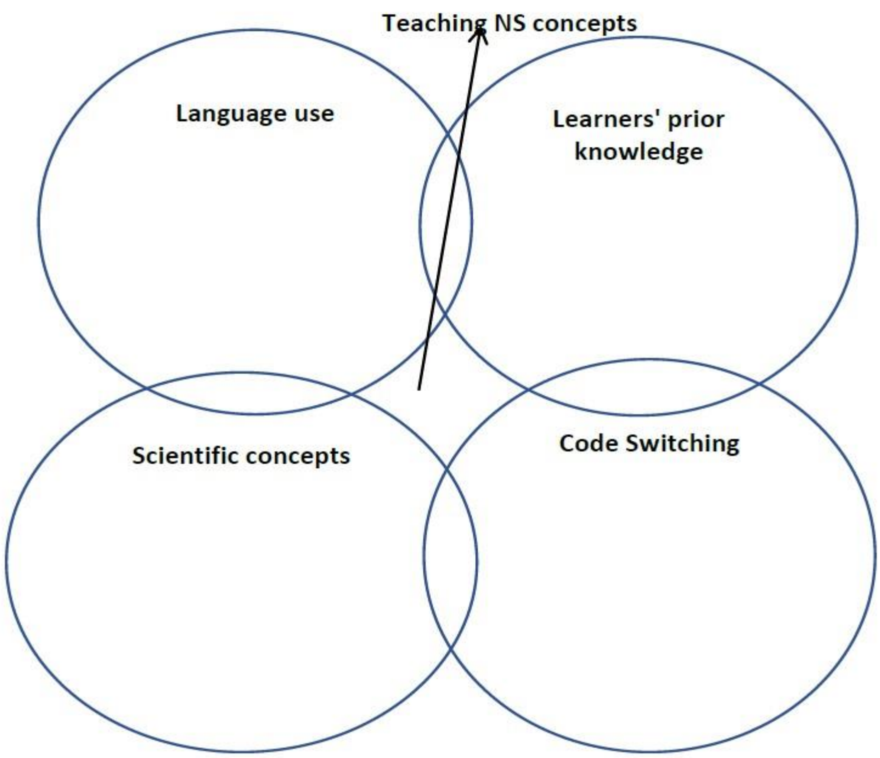


Figure 5.1: representation of the teaching and learning of NS concepts framework.

This framework consists of four interrelated pillars which are meant to recognise and uphold teaching of NS concepts. The supports identify the challenges of teaching and learning of NS concepts and providing a solid foundation for English second language learners where learning takes place. Making the science real, relevant and rigorous helps learners become more successful. Teachers are active at supporting learners through the affective domain and are able to show improvements in learners' learning and theoretical achievement in NS concepts. The framework is likely to guide and direct teachers on viable and sustainable strategies in the teaching of NS concepts. Implementation of framework motivates learners on doing science activities and gives ideas that address both their cognitive and affective needs. It serves elementary science teachers well to take advantage of the learners' interests as a source for engaging and motivating learners to elevated levels of achievement

The following sub-sections are a discussion of the major provisions of each of the proposed framework's four pillars or components.

5.5.1.1 Language use

Language plays an important role in learning. Theoretical values show that an important part of constructivism is that learning is dependent on the ability of learners to construct the scientific meanings. Language is considered an essential tool that learners use in constructing their own meanings. It is essential that learners develop proficiency in the language of science so that they are able to acquire the science knowledge. Learning refers to the interaction between the teacher, the teaching, and the learner; and there would be no learning without teaching. This implies that effective teaching and learning is a product of various interactions between the teacher and the learner that involve creativity by the teacher and the learner in terms of teaching and learning strategies. In the case of science teaching and learning, creativity is essential for promoting scientific concepts. Learners understand science better when they use the language of science through talking, reading and writing.

5.5.1.2 Scientific concepts

Knowledge in NS is needed for different purposes in different situations. The conceptual framework in this study identified the activities in which the learners need knowledge in science. It might be that scientific knowledge affects a decision. NS learning area requires learners to conduct scientific investigations by themselves to get a better understanding of science. That is, science investigations are purposeful. Learners acquire scientific literacy (chapter 2). Scientific concepts as a level of competence in understanding and using knowledge of science, are needed in each learner. NS concepts emerge through scientific investigations that develop the learners' knowledge during teaching and learning. If the teachers interacted with the learners in an interesting way, and through a language they all understood, it would reinforce the learners' positive attitudes towards learning.

5.5.1.3 Learners' prior knowledge

The use of language as a cognitive tool in teaching, learning and knowledge construction is another provision of the framework informing the study. Learning science involves learning the language of science which is complex, abstract and highly specific, with structural images and lexical density. In this essentially constructivist view of learning, the knowledge for learners to construct is already known to the teacher. Learners' prior knowledge, the needs and interests of the learner, and the curriculum emerges from these needs and interests. The teacher in general mind has the learner needs to demonstrate and provide learning experiences or activities which enable them to move towards greater achievement. In the Curriculum Framework for primary and secondary schools, the features that show that the learner can use his/her prior knowledge were described. Curriculum development, particularly the development of learning programmes and materials, should put learners first, recognising and building on their knowledge and experience, and responding to their needs.

5.5.1.4 Code-switching

As already mentioned in this study, the ability to code switch is very important for both the teacher and student in the learning process, particularly in the teaching of science, and within the context of a multilingual and diverse society like South Africa. The study has shown that code-switching as a science teaching strategy simplifies learning. It is effective for understanding the NS concept, enhances the learner's performance in the science subject, and improves the learners attitudes towards the science subject and the readiness to work together as a group. Code-switching was also used effectively for clarification and classroom control.

5.6 LIMITATIONS OF THE STUDY

The study focused on a small number of Natural Science HoDs, teachers and learners in the township primary schools in the East London District. The results could, therefore, not be generalised to apply the entire population of South African NS teachers.

The study only investigated the school component, that is, the teachers and learners. It did not involve other stakeholders such as the district curriculum component which includes the subject specialists and the subject advisors. Therefore, information that was gathered was only from the school perspective and lacked perspectives from science subject specialists.

The focus group interview with Grade 7 learners was, by and large, conducted in the code-switching (isiXhosa) because of the level of the learners' English proficiency. A major advantage, however, was that the researcher spoke the same language as the participants and there were no problems of translations. Furthermore, another limitation of this study was the similarity in responses given by the teachers about actual and ideal science teaching and learning based on individual perceptions, and this may not have honestly revealed the true picture of the situation at stake.

The researcher did the study in the Second Language to his home language. Even when collecting data, the classes from which the data was collected were supposed to use isiXhosa because the teachers and learners were all from isiXhosa speaking community.

5.7 CONCLUSION OF THE STUDY

This study dealt with the teaching of NS concepts to English second language learners in primary schools. Learning Science in the English medium disadvantaged learners because they had to grapple with the language itself and the technical terms, they encountered in their Science texts. However, learning opportunities are not designed to meet the basic learning needs of the learners if the language of learning and teaching becomes a barrier to knowledge. The priorities urgently established the human resources, financial resources and material be critically assessed. Arrangement with a view to increasing the teaching and learning of NS are neither adequate nor sufficient to meet the challenges of the present nor of the future of Science through English. It emerged that educators experienced difficulties in implementing some of the strategies because the theoretical underpinnings could have been contrary to their own beliefs. Teachers used instructional strategies that respected and built on differences while helping all learners learn important concepts and skills in science, particularly NS concepts. The researcher found that educators could be encouraged and supported by the school administration, parents and the larger community. Research is important because it is through rigorous investigations that government is appropriately advised about the delivery of believable language programmes in the learning and teaching of Science in primary schools.

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APPENDIX 1: INFORMED CONSENT FORM FOR LEARNERS

I .... hereby give my consent to become a participant in this study. I fully understand and agree to the terms and accept to be a participant in this study.

....

Participating teacher/learner School Contact details:

Address:...

....

....

Telephone numbers (School)...

Signed this day of .... 2018 at ....

Witness..Parent……………………………………

University of Fort Hare
Together in Excellence

APPENDIX 2: INFORMED CONSENT FORM FOR TEACHERS

I agree to participate in this research

I noted the information and had an opportunity to ask questions about it.

I agree to my responses being used for research purpose on condition that my privacy is respected. I understand that I am under no obligation to take part in this research and have the right to withdraw at any stage

I want to remain anonymous

YES NO Please circle your answer.

_X__________________________ Signature of Participant

University of Fort Hare
Together in Excellence

APPENDIX 3: INTERVIEW GUIDE FOR SCHOOL HEADS

SECTION A: DEMOGRAPHIC DATA FOR THE SCHOOL HEAD OF DEPARTMENT (HoD)

1. Gender………………………………
2. What is your age?
3. How long have you been a teacher?
4. How long have you been in office as a school head?
5. What is your highest professional qualification?
6. What is your understanding of Natural sciences concepts

INDIVIDUAL INTERVIEWS WITH SCHOOL HEADS

STUDY GUIDING RESEARCH QUESTIONS	INTERVIEW QUESTIONS
1. How do teachers link the teaching of Natural Science concepts to learners' prior knowledge?	• What understanding of prior everyday knowledge and experiences associated with science concepts teachers come with to a classroom. • As HoD what are the main factors that you think affect teaching and learning of Natural sciences concepts? • During classroom activities and lesson delivery, do teachers display the value of NS as an important subject • Do you ever visit teachers in class while teaching is in progress? And what do you notice?

	• Do teachers provide relevant learning materials that motivate learners for effective learning? • How is Natural sciences conceptualised by senior phase teachers? • What are senior phase teachers' understandings of the natural sciences curriculum?

	- How do teachers' understandings of Natural sciences influence their ability to implement a transformational curriculum? - Do teachers listen to the ideas and opinions of learners in their classes?
2. What learner-centred strategies are utilised in the teaching and learning of Natural sciences concepts?	- Why is it necessary for the school management team to be involved in the teaching of Natural sciences concepts? - What are your suggestions for the future planning of natural sciences curriculum in schools? - Are you aware of the different science teaching approaches? - What are some of the teaching approaches that you normally use? - How useful are your teaching approaches in enhancing student learning of science? - To what extent do your students participate in the carrying out of experiments in science learning? - Do your students work on science related projects? If so, give examples. - Do you employ small group teaching in the teaching of Natural Science? - Do you try to link new concepts to what students already know? If so, give examples of some of the concepts.

3. How do strategies employed by teachers assist learners in learning Natural sciences concepts?	- What instructional strategies do natural sciences educators use in teaching and learning? - What assessment strategies, processes and procedures do Natural sciences educators commonly use in the implementation of a lesson?

	• Does the availability of resources affect your teaching strategies used? Explain. • How available and qualified are the science teachers in the school? • Do you have Science specialists by training as teachers teaching NS in your school? • What can you say about the issue of policy documents and the teaching and learning of NS? • What district or provincial support is given to NS teachers?
4. What challenges do teachers and learners encounter in the teaching and learning of science concepts?	• What is the issue of resources regarding the teaching and learning of Natural Science? • How does students' background affect the teaching and learning of NS? • How does the issue of English as a language of instruction affect the teaching and learning of NS? • In your view is time allocated teaching of Natural sciences adequate. • What challenges are encountered in the school in the teaching of NS? • How are these challenges affecting the teaching and learning of NS?

	• What measures are you taking to address the challenges? • As an educator and HoD of Natural Sciences what are the key problems that you face when it comes to teaching the subject?

	• What are the attitudes of teachers, students, parents, and the school towards the use of English as medium of instruction in learning of NS at primary schools? • With the given grade 7 curriculum for Natural Sciences is the time allocated to complete the syllabus sufficient. • What in your opinion should be done to help improve the rate of Natural Sciences at your school?
5. What are the implications for science education?	• In terms of the policies that have been introduced for Natural Sciences by the Department of Education, do you feel it is suitable to government schools? Why? • What do you think could be done by the school administration to enhance the teaching and learning of NS in the school? • What do you think could be done by the Department of Education to enhance the teaching and learning of NS in the school? What policies inform the teaching of NS at senior phase level? • How does the new CAPS document inform the teaching and learning of NS?
	• Do you find the CAPS document easy to read and interpret? • What are some of the commonly expected learning outcomes in the teaching of NS?

	- What do you think could be done by parents to enhance the teaching and learning of NS in the school? - What are the implications for science education in the senior primary schools? - What in your opinion should be done to help improve the rate of Natural Sciences at your school? - Do learners whose home language differ from the medium of instruction, have a problem with understanding the concepts of Natural Sciences? - Do you think that teachers have a fundamental role in the teaching and learning of NS concepts in second language learners

THANK YOU FOR YOUR PARTICIPATION

APPENDIX 4: FOCUS GROUP INTERVIEWS FOR LEARNERS

INTRODUCTION

Your school has been selected to participate in this study to examine the teaching of Natural sciences concepts to English second language learners in primary schools. This study is a requirement for a Degree Thesis, and it intends to examine the teaching of Natural sciences concepts in the East London education primary schools.

INSTRUCTIONS

Please Answer all the questions below to the best of your ability. Please feel free to elaborate on your responses. Your responses are confidential. Therefore, you and requested NOT to write your name or the name of your teacher/school anywhere on the pages or mention it in your responses.

STUDY GUIDING RESEARCH QUESTIONS	INTERVIEW QUESTIONS
1. How do teachers link the teaching of Natural Science concepts to learners' prior knowledge?	• **TEACHING OF NS CONCEPTS** • How do the teachers link learner's prior knowledge to understand scientific principles better? • What do you think could be done by teachers to enhance the teaching and learning of NS concepts in the school? • What problems do you usually have when understanding the NS concepts? • What do you think could be done by parents to enhance the teaching and learning of NS concepts in the school? • What do you think could be done by learners themselves to enhance the learning of NS in the school? • What do you think could be done by the school administration to enhance teaching and learning of NS in the school?

2. What learner-centred strategies are utilised in the teaching and learning of Natural sciences concepts?	• **LEARNER-CENTRED STRATEGIES** • Which language do you prefer to use when learning NS concepts? Why? • Do you think the teaching approaches employed are useful in enhancing student learning of science? • How comfortable are you as a Xhosa -speaking learners in planning and structuring projects in NS where the LOLT is English? • Do you engage in practical activities at school for NS? If so, does it help to improve your understanding of the subject? • If NS were taught to you in your home language, would you have a better understanding of the subject and your performance in it would improve? • How can the mother tongue be utilized in the NS classroom to ensure that skills, knowledge, values and attitudes are the results of learning?
3. What challenges do teachers and learners encounter in the teaching and learning of science concepts?	**4. RESOURCES IN SCIENCE TEACHING AND LEARNING** **5.** Is there a purposefully built science laboratory in the schools? **6.** Do you have adequate apparatus and other equipment for carrying out of experiments and practical work in in science? **7.** Do you have adequate textbooks and reference materials in learning of science?

	8. In your view, is time allocated to teaching of Natural sciences adequate? 9. What, in your view, could be done to address the challenges in your learning of NS? 10. How does the issue of English as a language of instruction affect your learning of NS? 11. Are you interested in learning NS? Why? 12. How do you cope in understanding the concepts of NS in the additional language? 13. Do you get any support from home in your learning of science? If so, what kind or form of support do you get? 14. What other challenges do you encounter in learning NS? 15. Were learners face difficulties with switching from one language of teaching and learning to another?
1. What are the implications for science education?	2. effects for science education 3. What benefit do as a learner get on learning NS concepts? 4. What do you think could be done by the school government to improve teaching and learning of NS concepts in the school? 5. Which language would you choose for your assessments or do you use to communicate during NS period? Why? 6. What are some of the major difficulties you as a grade 7 learner experience with NS? 7. What do you think could be done by teachers to develop the teaching and learning of NS in the school?

	8. What do you think could be done by parents to enhance the teaching and learning of NS concepts in the school? 9. What do you think could be done by learners themselves to enhance the learning of NS in the school?

THANK YOU FOR YOUR PARTICIPATION

APPENDIX 5: QUESTIONNAIRE FOR TEACHERS

QUESTIONNAIRE FOR TEACHERS

INTRODUCTION AND CONSENT

Hello. My name is Nomaroma Kumanda. I am a PhD candidate studying with University of Fort Hare, Eastern Cape, South Africa. As part of the requirements of the degree programme. I am conducting a study entitled: "**teaching of Natural sciences concepts to English Second language learners in primary schools in the East London education district: Implications for science education''.** The data gathered will assist to improve the Ministry of senior Primary schools and your school in strengthening the role of teachers in the teaching of Natural sciences concepts to English second language learners. Your school has been selected to participate because of the work you are already doing in this area. Hence, your views are of great value.

My target audience include school heads of department (HoDs); grade 7 Natural sciences teachers and grade 7 natural sciences learners. I am requesting you to honestly complete this questionnaire. Please be assured that your responses are confidential so feel free to be as open as possible.

INSTRUCTIONS

Please indicate your responses with an**(X)** in the appropriate box or filling in the provided spaces with brief explanatory notes.

SECTION A: BIOGRAPHIC DATA FOR TEACHERS

Your School Status: (Boarding/Day) …………………School Composition: (Boys/Girls or Both)...........

1. Gender

Male	Female
1	2

2. Age in years

25 and below	26 to 30	31 to 35	36 to 40	41 to 50	51 and above
1	2	3	4	5	6

3. Highest academic qualification

"O" Level	"A" Level	Bachelor's Degree	Master's Degree	Doctoral Degree	Other(Please state)
1	2	3	4	5	6

4. Highest professional qualification

Certificate	Diploma	Any other (please state)
1	2	3

5. Position of responsibility in the school

Subject teacher	Class teacher	Head of department	Senior teacher
1	2	3	4

6. Natural sciences teaching experience

Below I year	1 – 2 years	3 -4 years	5 – 6 years	7 years and above
1	2	3	4	5

SECTION B: EXAMINING THE TEACHING AND LEARNING OF NATURAL SCIENCES CONCEPTS TO ENGLISH SECOND LANGUAGE LEARNERS.

This section seeks to generate information about how to teach natural sciences concepts challenges encounter by teachers.

There are challenges learners face based on Natural sciences concepts Views about the language challenges in science learning

7. Please read each of the following statements very carefully and tick the answer which best describes your degree of agreement or disagreement.

The following options are given. Strong agree, agree, disagree, and strongly disagree

NO	CHALLENGES LEARNERS FACE BASED ON NATURAL SCIENCES CONCEPTS	STRONG DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
		1	2	3	4
a.	**English language foundations contribute to challenges in science learning**				
b	**learners can follow scientific instructions**				
c.	**challenges learners face based on prior knowledge**				
d.	**challenged switching from one language of teaching and learning to another**				
e.	**English as a language of teaching influence interaction in Science classroom**				
f.	**Learners have adequate interpersonal communication skills.**				
g.	**Challenges/problems while using English to learn in your Science class?**				

From the **challenges learners face based on Natural sciences concepts** listed above, choose one and show how it relates to the NS concepts

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

Linking of teaching of NS concepts	Strong disagree	disagree	agree	Strongly agree
	1	2	3	4
a. Teachers link the teaching of Natural sciences concepts to learners' prior knowledge				
b. Lessons in English complicate our pupils' understanding of scientific concepts.				
c. English as a language of teaching influence interaction in Natural sciences classroom				
d. Attitudes of teachers affect the effectiveness of science curriculum				
e. Curriculum affect teaching and learning of Natural sciences concepts				
f. learners show interest in learning natural sciences concepts				
g. New Natural sciences concepts are linked to what students already know				
h. Topics in NS are based on the core knowledge, concepts and unifying statements set out in the NS policy document.				
i. Core knowledge and concepts of NS develop an interest in learners studying NS related subject				

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

8. Indicate with an (X) on agreement how you are with the following statement how do teachers link the teaching of Natural sciences concepts to learners' prior knowledge:

Mark with an (X) from the statement above choose one and explain in details

……

……

……

……

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

learner-centred strategies in teaching and learning of Natural sciences concepts	**Excellent**	**Very good**	**good**	**fair**	**poor**
a. Utilise relevant methods carry knowledge and skills across.					
b. Teachers view teaching as telling and learning in Natural sciences					
c. Science teachers should make use of inquiry in teaching to challenge learners.					
d. Learners get support from home in their learning of science.					
e. Teaching of natural sciences in English increase the learner's confidence in school.					
f. Learners are prone to rote, learn and memorize facts and concepts without understanding.					

g. Teachers provide interesting methods together with a learning environment using models, simulating, diagrams and concepts maps					
h. Teachers can improvise to make learning more interesting.					
i. Students participate in the carrying out of experiments in science learning					
j. Teaching approaches employed are useful in enhancing student learning of science					
k. Learner-centred education is perceived as more suitable than traditional forms of education					
l. Some strategies could be used to facilitate comprehension of particular Natural Sciences concepts with ESL learners					
m. The teacher makes use of teaching strategy to allow the learners to study the words critically and conceptually					

9. Indicate how you rate the level of your understanding of the following strategies in the teaching and learning of NS concepts

from the above strategies which one(s) are more relevant and applicable to you as a teacher?...
....………………

…………………………..

Give reasons for your choice above

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

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

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

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……………………………………………………………

What comments do you have regarding your understanding of the learner-centred strategies in teaching and learning of Natural sciences Concepts?

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

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

……………………………………………………………………

SECTION C: Challenges do teachers and learners encounter in the teaching and learning of science concepts

9. Below are the statement that could relate to the challenges towards teaching and learning science concepts. Please make a cross (X) that best describes your position: Strongly agree, Agree, Disagree /strongly disagree

CHALLENGES IN THE TEACHING AND LEARNING OF NS CONCEPTS	Strong disagree	Disagree	Agree	Strongly agree
a. Teachers and learners encounter challenges in the teaching and learning of science concepts				
b. There are attitudinal problems toward learning and teaching of NS				
c. Students easily understand all the concepts, words and contents given in the NS textbooks.				
d. Learning and teaching in primary schools enables students to be confident in their learning.				
e. Teaching and learning through one’s own language in primary schools limits students’ understanding and knowledge.				
f. Engagement in practical activities at school for natural Science?				

g. Teachers have sufficient opportunity to attend seminars and workshops to improve their science teaching				

Give any more suggestions on how to deal with the challenges in the teaching and learning of science concepts

....

....

Do you think that teachers have a pivotal role in the teaching and learning of NS concepts?

a. Yes	
b. No	
c. Not sure	

SECTION D: IMPLICATIONS FOR SCIENCE EDUCATION

IMPLICATIONS FOR SCIENCE EDUCATION	ALWAYS	REGULARLY	SOMETIMES	NEVER
a. English LoLT influence the performance of learners in Science learning area				
b. Teachers experience problems when using English as a language of teaching Science.				
Code-switching is an approach used in Natural sciences Classroom				
Learners struggle with the formation of Science concepts.				

Teachers' understandings of natural sciences influence their ability to implement a transformational curriculum				
Support received from school when implementing or teaching natural sciences in English curriculum.				
English LoLT is a barrier to Science learning				
Teachers' understandings of natural sciences influence their ability to implement a transformational curriculum.				

Please indicate *how* frequently you use *each* of the following implications and give a brief comment at the bottom of this section

Use the keys given below to indicate your response for each item statement: always, regularly sometimes/ never

What are your views as science educator on the challenges faced by learners when English is used as a medium of instruction in science?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………

THANK YOU FOR PARTICIPATING IN THIS STUDY

APPENDIX 6: QUESTIONNAIRE FOR LEARNERS

INTRODUCTION

Your school has been selected to participate in this study to examine the teaching of natural sciences concepts to English second language. This study is a requirement for a Degree Thesis and its findings intend to strengthen the role of teachers in teaching natural sciences concepts in East London primary schools.

PREAMBLE OF THE NATURAL SCIENCES CONCEPT

Natural sciences concept is an international educational intervention which mandates schools to have curriculum implementation procedures; conditions; policies; rules and regulations; learner management strategies; teacher-pupil and pupil-pupil interactions that recognize and uphold the rights of the children.

INSTRUCTIONS

You are kindly requested to answer **ALL** the given questions. Do not write your name on the questionnaire. The researcher would want to assure you that the information gathered was kept confidentially and strictly used for the purpose of this study. Your honest responses to the questions will contribute to the success of this study. Tick (√) in the appropriate box, and where detail is required, please fill in the information in the spaces provided. It is likely to take you 20– 30 minutes to answer the questions.

SECTION A: BIOGRAPHIC DATA FOR LEARNERS

10. Gender

Male	Female
1	2

11. Age in years

13 and below	14- 16	17 and above
1	2	3

12 School pupil's composition

Boys and girls	Boys only	Girls only
1	2	3

13 School position of responsibility

Head boy/Head girl	Vice Head boy/girl	Prefect	Class monitor/ representative	No position of responsibility
1	2	3	4	5

SECTION B: TEACHING OF NATURAL SCIENCES CONCEPTS TO ENGLISH SECOND LANGUAGE LEARNERS USING THEIR PRIOR KNOWLEDGE.

How does your teacher link the teaching of Natural sciences concepts to prior knowledge? Indicate by a tick **(**√) your response to the following statements using following as indicators.

Statement on the link of learners prior knowledge	**Strong disagree**	**disagree**	**agree**	**Strongly agree**
a. Easily use of prior knowledge to understand scientific concepts.				
b. Teachers help learners to learn by participation				
c. learners have mastered the required concepts				
d. The teacher helps the learners to respond intuitively				
e. Learners are actively given feedback in communication, accuracy of knowledge, skills and thought process by the teacher				
f. Teacher show confidence and knowledge in teaching the subject.				

What else do teachers link the teaching of Natural sciences concepts to prior knowledge?

……

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

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

……………

What would you consider to be the link between assessment and instructional (teaching/learning) approaches?

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

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

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

……………

Are there any comments you would like to make regarding this topic?

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

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

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

……………

SECTION C: LEARNER-CENTRED STRATEGIES UTILISED IN THE TEACHING AND LEARNING OF NATURAL SCIENCES CONCEPTS

Indicate by tick (√) the frequency in use of the suggested strategies utilised in the teaching and learning of Natural sciences concepts

LEARNER-CENTRED STRATEGIES TEACHING AND LEARNING OF NATURAL SCIENCE CONCEPTS	Every time	Almost every-time	sometimes	Almost never	never
	5	4	3	2	1
a. Learners are encouraged to play an active role in the classroom activities					
b. Understanding of the meaning of the natural sciences concepts					
c. Engage with learning and teaching natural sciences					
d. Always actively involved in the learning process					

e. Construct are in tune with accepted scientific explanations.					
f. Effective teaching and learning is a product of various interactions between the teacher and the learner					
g. Teaching and learning is a two-way process with the learner and educator working together					
I. work as groups in the classroom					

Give any other learner-centred strategies utilised in the teaching and learning of natural sciences concepts……………………………………………………………………………………………

……

……

…………

SECTION D: STRATEGIES EMPLOYED BY TEACHERS ASSIST LEARNERS IN LEARNING NATURAL SCIENCES CONCEPTS

Indicate by tick **(√)** the frequency in use of the suggested strategies employed by teachers assist learners in learning Natural sciences concepts, *1=strongly agree; 2: agree; 3: disagree; 4: strongly disagree*

Strategies employed by teachers	**Strongly agreed**	**agree**	**Disagree**	**Strongly disagree**
	1	2	3	4
a. The teacher improve learner's interest in science.				
b. science teaching in learning natural sciences has a strong long-term impact				
c. Teachers encourage more students to study science				
d. Improving aspects of education may be broader or narrower.				
e. Teachers allow all learners to demonstrate more positive patterns in understanding of science concepts and vocabulary.				

f. Teacher involve creativity in terms of teaching and learning of natural sciences concepts.				
g. teacher as a science expert				
h. teacher answer all the questions asked by learners about what he or she was teaching				
i. teacher explains well what he or she was teaching				
j. Science concept circle helps the learners to form the conceptual relationships among identified words				

Just list other strategies that can be employed by teachers to assist learners in learning Natural sciences concepts

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………

According to your views what can you say about the way of teaching natural sciences general?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

SECTION E: CHALLENGES ENCOUNTERED BY LEARNER IN TEACHING AND LEARNING OF NATURAL SCIENCES CONCEPTS

Indicate by a tick (√) challenges teachers and learners encounter in the teaching and learning of natural sciences concepts *Scale range:* **All of the time Most of the time, Sometime, Not often, Never**

Challenges encountered by learners in teaching and learning of science concepts	**All of the time**	**Most of the time**	**Some time**	**Not often**	**Never**
	1	2	3	4	5

a. It is difficult for learners to understand the new natural sciences concepts when the teacher explains in English					
b. Learners explore how the language of instruction influences the teaching of natural sciences concepts					
c. Language is very important to improve the quality of science education					
d. Learners become adept at code-switching in challenge they encounter					
e. Learners struggle with the formation of Science concepts					
f. The are problems experienced by learners when they use English as a language of teaching Science					
g. English LoLT Influence the Performance of Learners in Science teaching					

What are your general suggestions that you think can decrease the challenges in teaching and learning of science concepts in primary schools?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………..

SECTION F: THE IMPLICATIONS FOR SCIENCE EDUCATION

For the following part of the education implications in NS concepts, please indicate your level with the statement by marking square with X, 1=strongly agree; 2: agree; 3: disagree; 4: strongly disagree

IMPLICATIONS FOR SCIENCE EDUCATION	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE
	1	2	3	4

Learning science is beneficial to learners				
learners have limited academic language proficiency				
learners lack understanding of English academic language				
learners fail and under archive due to use of a language which is not their home language or mother tongue				
the curriculum is focused on preparing students for study science				
English home language helps to understand scientific terms				
learners do not benefit much when learning science in English,				

In terms of the policies that have been introduced for natural Sciences by the Department of Education, do you feel it is suitable?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………

THANK YOU FOR YOUR COOPERATION

APPENDIX 7: LETTER TO SCHOOL PRINCIPAL

University of Fort Hare Faculty of Education

Sir/Madam (Principal)

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH WITH NATURAL SCIENCES EDUCATORS AND GRADE 7 LEARNERS IN YOUR SCHOOL.

I am registered for PhD in the Faculty of Education at Fort Hare University. I am writing this letter to request for permission to conduct research with Senior Phase educators and Grade 7 Natural Sciences learners in your school.

My investigation is entitled: TEACHING OF NATURAL SCIENCES CONCEPTS TO ENGLISH SECOND LANGUAGE LEARNERS IN PRIMARY SCHOOLS IN THE EAST LONDON EDUCATION DISTRICT: IMPLICATIONS FOR SCIENCE EDUCATION

The names of schools, educators and learners in the study was treated as confidential. Your permission to allow me conduct research in your school was highly appreciated. I can be contacted on buqaqa2@gmail.com or 0736122930.

University of Fort Hare
Together in Excellence

Thank you in advance

Yours faithfully

Nomaroma Kumanda (Researcher)

APPENDIX 8: LETTER TO THE DEPARTMENT

Education Department East London

Faculty of Education University of Fort Hare

Dear Sir

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH NATURAL SCIENCES EDUCATORS AND LEARNERS.

I am registered for Phd in the Faculty of Education at Fort Hare University and a foundation phase educator at Makinana Public School. I am writing this letter to request for permission to conduct research with grade 7 educators and learners in purposively selected schools in East London District. My investigation is entitled: *TEACHING OF NATURAL SCIENCES CONCEPTS TO ENGLISH SECOND LANGUAGE LEARNERS IN PRIMARY SCHOOLS IN THE EAST LONDON EDUCATION DISTRICT: IMPLICATIONS FOR SCIENCE EDUCATIO*N

Your permission to allow me conduct research in your school was highly appreciated.

A copy of approval from the Strategic Planning, Policy and Research from Zwelitsha is attached

I hope it meets your approval. The names of schools, educators and learners in the study was treated as confidential, but the results of the research can be forwarded to your office should you wish me to do so. Your permission to allow me conduct research in East London was highly appreciated. I can be contacted on buqaqa2@gmail.com or 0736122930.

Thank you in advance

Yours faithfully

Nomaroma Kumanda (Researcher)

APPENDIX 9: LETTER FROM THE DEPARTMENT

Province of the
EASTERN CAPE
EDUCATION

STRATEGIC PLANNING POLICY RESEARCH AND SECRETARIAT SERVICES
Steve Vukile Tshwete Complex • Zone 6 • Zwelitsha • Eastem Cape Private
Bag X0032 • Bhisho • 5605 • REPUBLIC OF SOUTH AFRICA

Tel: +27 (0)40 608 4773/4035/4537 • Fax: +27 (0)40 608 4574 • Website: www.ecdoe.gov.za

Enquiries: B Pamla Email: babalwa.pamla@ecdoe.gov.za Date: 22 March 2018

Mrs. N Kumanda
36 Swartbery Road Egoli
Ext.
Amalinda
East London
5201

University of Fort Hare
Together in Excellence

Dear Mrs. Kumanda

PERMISSION TO UNDERTAKE A DOCTORATE THESIS: TEACHING OF NATURAL SCIENCES CONCEPTS TO ENGLISH SECOND LANGUAGE LEARNERS IN PRIMARY SCHOOLS IN THE EAST LONDON EDUCATION DISTRICT - IMPLICATIONS FOR SCIENCE EDUCATION

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1. Thank you for your application to conduct research.

2. Your application to conduct the abovementioned research from the eight selected primary schools under the jurisdiction of the Eastern Cape Department of Education (ECDoE) is hereby approved based on the following conditions:

   a. there will be no financial implications for the Department;

   b. institutions and respondents must not be identifiable in any way from the results of the investigation;

   c. you present a copy of the written appmval letter of the Eastern Cape Department of Education (ECDoE) to the Cluster and District Directors before any research is undertaken at any institutions within that particular district;

   d. you will make all the arrangements concerning your research;

e. the research may not be conducted during official contact time;

f. should you wish to extend the period of research after approval has been granted, an application to do this must be directed to Chief Director: Strategic Management Monitoring and Evaluation;

g. your research will be limited to those institutions for which approval has been granted, should changes be effected written permission must be obtained from the Chief Director: Strategic Management Monitoring and Evaluation;

h. you present the Department with a copy of your final paper/report/dissertation/thesis free of charge in hard copy and electronic format. This must be accompanied by a separate synopsis (maximum 2 — 3 typed pages) of the most important findings and recommendations if it does not already contain a synopsis;

i. you present the findings to the Research Committee and/or Senior Management of the Department when and/or where necessary;

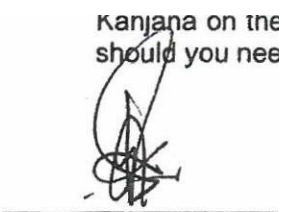
j. you are requested to provide the above to the Chief Director: Strategic Management Monitoring and Evaluation upon completion of your research;

k. you comply with all the requirements as completed in the Terms and Conditions to conduct Research in the ECDoE document duly completed by you; l. you comply with your ethical undertaking (commitment form);

m. you submit on a six-monthly basis, from the date of permission of the research, concise reports to the Chief Director: Strategic Management Monitoring and Evaluation.

3. The Department reserves a right to withdraw the permission should there not be compliance to the approval letter and contract signed in the Terms and Conditions to conduct Research in the ECDoE.

4. The Department will publish the completed Research on its website.



5. The Department wishes you well in your undertaking. You can contact the Director, Ms. NY Kan' a on the numbers indicated in the letterhead or email nelisa.kanjana@egdpe.gov.za s ul you need any assistance.

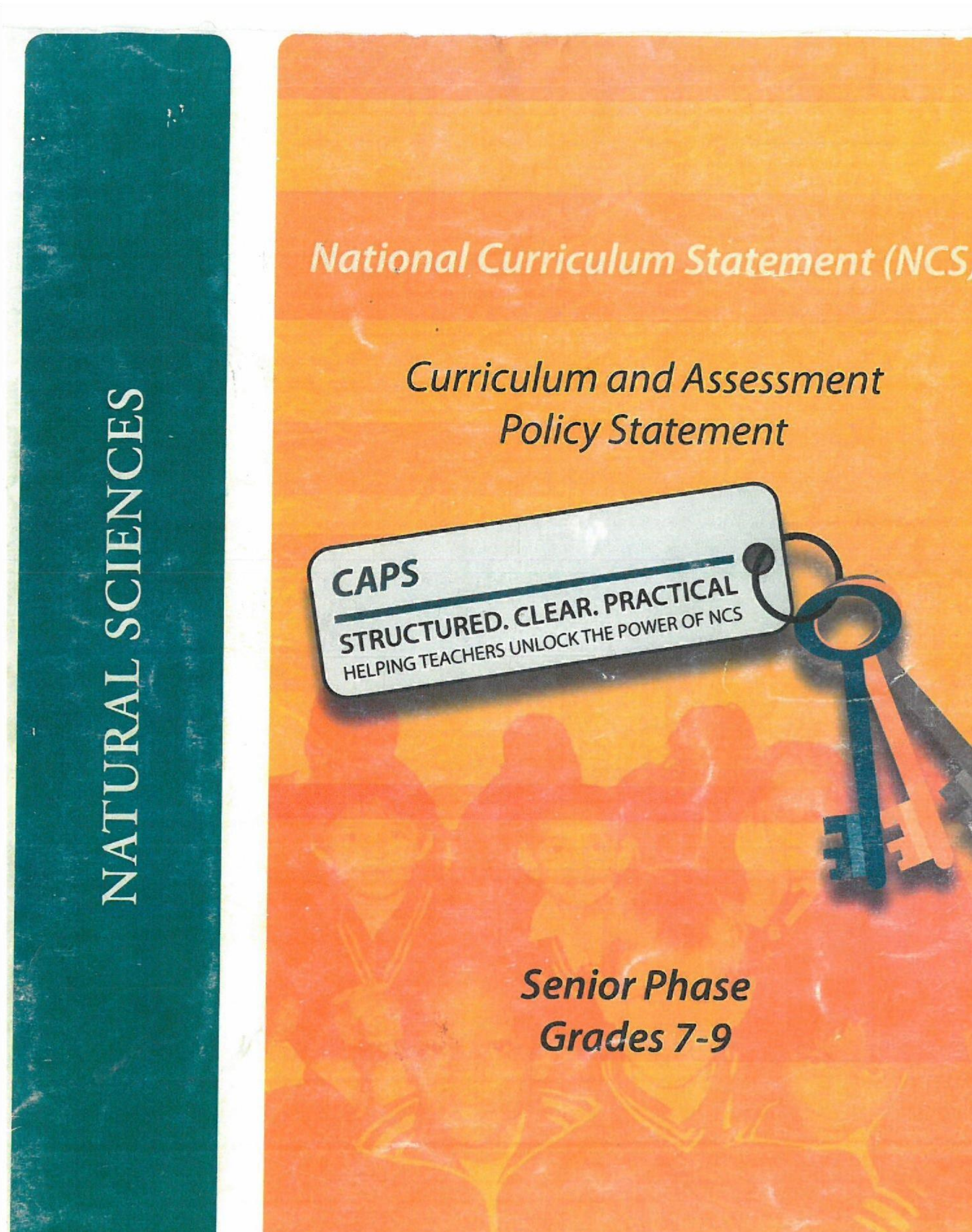
NY KANJANA
DIRECTOR: STRATEGIC PLANNING POLICY RESEARCH & SECRETARIAT SERVICES

FOR SUPERINTENDENT-GENERAL: EDUCATION

bullding blocks for growth Page 2 of 2

Ikamva eliqaqambileyo!

APPENDIX 10: NATURAL SCIENCES POLICY DODUMENT



APPENDIX 11: ETHICAL CERTIFICATE

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ETHICAL CLEARANCE CERTIFICATE

REC-270710-028-RA Level 01

Certificate Reference Number: MAPI 51 SKUMOI

Project title:	Teaching of Natural sciences concepts to English second language learners in Primary schools in the East London education District: Implications for science education.
Nature of Project	PhD in Education
Principal Researcher:	Nomaroma Kumanda
Supervisor:	Prof C Maphosa
Co-supervisor:	N/A

On behalf of the University of Fort Hare's Research Ethics Committee (UREC) I hereby give ethical approval in respect of the undertakings contained in the abovementioned project and research instrument(s). Should any other instruments be used, these require separate authorization. The Researcher may therefore commence with the research as from the date of this certificate, using the reference number indicated above.

Please note that the UREC must be informed immediately of

Any material changes in the conditions or undertakings mentioned in the document

Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research

The Principal Researcher must report to the UREC in the prescribed format, where applicable, annually, and at the end of the project, in respect of ethical compliance.

Special conditions: Research that includes children as per the official regulations of the act must take the following into account:

Note: The UREC is aware of the provisions of s71 of the National Health Act 61 of 2003 and that matters pertaining to obtaining the Minister's consent are under discussion and remain unresolved. Nonetheless, as was decided at a meeting between the National Health Research Ethics Committee and stakeholders on 6 June 2013, university ethics committees may continue to grant ethical clearance for research involving children without the Minister's consent, provided that the prescripts of the previous rules have been met. This certificate is granted in terms of this agreement.

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The UREC retains the right to

- Withdraw or amend this Ethical Clearance Certificate if o Any unethical principal or practices are revealed, or suspected o Relevant information has been withheld or misrepresented o Regulatory changes of whatsoever nature so require. The conditions contained in the Certificate have not been adhered to

- Request access to any information or data at any time during the course or after completion of the project.

- In addition to the need to comply with the highest level of ethical conduct principle investigators must report back annually as an evaluation and monitoring mechanism on the progress being made by the research. Such a report must be sent to the Dean of Research's office

The Ethics Committee wished you well in your research.

Yours sincerely

Profe essor L or Lindelwa Majova-Songca
Acting Dean of Research

10 November 2017

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APPENDIX 12: LANGUAGE EDITING CERTIFICATE

SOLPL A A T J E UNIVERSITY

Dr. J. Sibanda (Senior Lecturer: English)

School of Education Private Bag X 5008, Kimberley, 8300 North Campus, Chapel Street, Kimberley E-mail:
Jabulani.Sibanda@spu.ac.za jabusbnd@gmail.com Website: www .spu.ac.za Tel: 27534910142

Cell: 0845282087

28 November 2018

TO WHOM IT MAY CONCERN

I hereby confirm that I have proof read and edited the following PhD thesis using Windows 'Tracking' System to reflect my comments and suggested corrections for the author(s) to action:

- **Full Name**: Nomaroma Kumanda
- **Student Number**: 201203920

- **Title:** Examining the Teaching of Natural sciences Concepts to English Second Language Speakers in Selected Primary Schools in the East London Education District.
- **Date:** 28 November 2018

Although the greatest care was taken in the editing of this document, the final responsibility for the product rests with the author.

Sincerely

28.11.2018

SIGNATURE DATE

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