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IMPLEMENTATION OF THE NATURAL SCIENCE CURRICULUM IN SELECTED RURAL JUNIOR SECONDARY SCHOOLS IN THE COFIMVABA EDUCATION DISTRICT

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BY
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AT

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DECLARATION

I, the undersigned, Nomxolisi Mtsi, hereby solemnly declare that the work contained in this dissertation is entirely my own original work with the exception of quotations or references which are attributed to their sources or authors. All the sketches and tables were produced by me except where I acknowledge that they were taken from another source.

This dissertation has not been submitted to, and will not be presented at, any other university for an equivalent or any other degree award.

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Signed .... Date 04-09-2015 ....

ABSTRACT

The purpose of the study was to explore how Natural Science (NS) curriculum was implemented in selected rural junior secondary schools in one education district in the Eastern Cape Province of South Africa. Four sub-research questions were set to gather insights on the implementation of the NS curriculum from school principals, NS educators and NS learners in the Cofimvaba education district. A case study design located in the intepretivist paradigm was employed. A qualitative approach was followed in an attempt to seek in-depth understanding of the issue from the point of view of participants. Three conveniently selected rural junior secondary schools participated in the study. Purposive sampling was used to select one school principal, one science teacher and six learners in each of the three selected rural schools. Data were collected using individual interviews with teachers and principals, focus group interviews with learners and observation of science lessons. To analyse data, qualitative content analysis method shall be used. Audio- taped interviews were transcribed and data were coded, sorted and categorised to ensure thematic analysis. The study found that there were challenges related to teacher preparedness in the teaching of NS. Such challenges were related to lack of specialisation in science as well as insufficient and irregular professional development programmes for NS educators. It was also established from the study that whilst educators claimed to be aware of different learner-centred and active learning approaches, such approaches were not always employed in the teaching and learning of NS because of numerous reasons. There were fundamental challenges that negatively affected the teaching and learning of NS and these included lack of basic infrastructure, resources, use of English of medium of instruction, lack of parental support, among others. The study revealed that participants had different and useful views on the roles that can be played by different stakeholders in enhancing the implementation of the NS curriculum in rural junior secondary schools. The study recommends that the Department of Education provide specialist teachers in schools and assist in professionally developing those currently in schools. Educators should be prepared in terms of pedagogical expertise in order to make use of constructivist teaching and learning approaches in the promotion of scientific literacy in learners. Support, monitoring and supervision mechanisms should be instituted to ensure close cooperation with educators to enhance Natural Science curriculum implementation as required and prescribed in curriculum documents.

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DEDICATION

The study is dedicated to my late father Deyi, Mshwawu, Zotsho for his special love, support and good guidance.

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ACRONYMS

ACRONYM	FULL DESCRIPTION
AAA	American Association for the Advancement of Science
B.Ed	Bachelor of Education
BGCSE	Botswana General Secondary Certificate
CAPS	Curriculum and assessment policy statement
DoE	Department of Education
ICT	Information and communication technology
IKS	Indigenous Knowledge Systems
JICA	Japan International Co-operation Agency
JSS	Junior secondary schools
LoLT	Language of Learning and Teaching
MST	Maths Science and Technology
MTBB	Mother Tongue Based Bilingual Education
NGOs	Non-Governmental Organisations
NOS	Nature of Science
NRC	National Research Council
NS	Natural Science
OBE	Outcomes Based Education
OECD	Organisation for Economic Co-operation and Development
PCK	Pedagogical Content knowledge
PTC	Primary Teachers diploma
ROSE	Relevance of Science Education
SCORE	Science Community Representing Education
SMASE	Strengthening of Mathematics and Science Education
SMK	Subject Matter Knowledge
STD	Senior Teachers diploma
TIMMS	Trends in Mathematics and Science Study
UNESCO	United Nations Educational, Scientific, and Cultural Organization

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CHAPTER ONE

RESEARCH CONTEXT AND BACKGROUND

1.1 INTRODUCTION

This introductory chapter of the study places the study within the international, African and South African context. It clarifies the statement of the problem and identifies the research questions the study seeks to address. The study provides a rationale for the study, defines key terms and also outlines chapters for the study.

1.2 BACKGROUND TO THE STUDY

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Science education is a very requisite component of secondary and high school curricula, the world over. Economic development hinges on technological advances based on scientific knowledge and s[illegible]re is a general shortage of science graduates in most developing and some developed countries and this negatively affects economic growth in almost all countries (Broecke, 2013). The teaching of science subjects in schools is very important for the economic and technological development of a country through advancing scientific knowledge. Africa should develop its scientific human resources in order to be self-reliant in the production of goods and services (Ogunniyi, 2004). The teaching of science and mathematics is important for human resource development.

Internationally, the teaching of science in European schools such as 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. Having many learners pursuing science related careers, therefore, alleviates the shortage of science graduates, who are key drivers in industrial development (Broecke, 2013). Regarding the approaches to science teaching in European schools, Science on Stage (2006:7) states that:

> Natural sciences are empirical and thrive on experiments. The role of the experiment in teaching science involves a high level of didactic and methodological requirements.

Teaching of science should be done using appropriate methods which allow learners to carry out experiments and come out with logical conclusions to scientific procedures and processes. The practical element of actually doing tasks in science should be emphasised.

In countries such as Greece, Portugal and Germany, the teaching of science in schools is done by well qualified and experienced teachers (Eurydice, 2006). There is a great investment in sound teacher training to produce teachers who know the content to be taught and are conversant with sound teaching approaches. It shows that these countries take the teaching of science in schools seriously by ensuring that the quality of teachers teaching the subject is high. On the importance of teacher competence in science teaching in European schools, Science on Stage (2006: 1) says:

> In teaching science, teachers have to stimulate the learners' interests and change preconceptions about science topics …. Students learn best when they are allowed to work out explanations for thems[illegible] time through a variety of learning experiences.

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In European countries, emphasis is placed on the appropriateness of teaching methods and the role of the teacher. Activity-based learning which assists in developing learners' interest in learning science is considered important.

The purpose of science teaching in European secondary and high schools is to ensure that learners develop scientific literacy (Science on Stage, 2006). Scientific literacy is referred to as 'a person's ability to comprehend and handle key concepts and basic scientific principles' (Science on Stage, 2006). In scientific literacy, the learner applies scientific knowledge to solve problems. Learning is not theoretical but practical and contextualised to meet society's needs.

In Africa, the teaching of Science is also taken seriously in most countries, however there are still challenges which are encountered at the implementation stage. Science curricula are often reviewed and revised to ensure that scientific skills and knowledge offered are relevant to the economic needs of a country. Ajaja (2009) observes that in Nigeria, the 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' (Ajaja, 2009). Learners are expected to apply knowledge and skills acquired in science to real life contexts. Ajaja (2009) further notes that the teaching of sciences in some Nigerian schools was negatively affected by teachers' reliance on the lecture method in science teaching. Science was also not allocated enough time in the school timetable despite it being a practical and activity-based subject which requires more time.

Nigeria seeks to develop the quality of science and maths education as this considered important for national development through the Strengthening of Mathematics and Science Education (SMASE) (2005) project, which is funded by Japan International Cooperation Agency (JICA) and runs until 2020. The main target in this project is teacher development. The country wants to improve the quality of science teachers to ensure that they have the necessary science content and teaching skills. The SMASE (2005) project aims to:

> ...shift teaching paradigm from 'banking style/chalk and talk' to 'ASEI & PDSI approach.' ASEI & PDSI approach is the effective approach for ensuring the quality of mathematics and science lessons and their steady improvement. ASEI, which an acronym for Activities, Students, Experiments and Improvisation is a key word in the SMASE project for lesson innovation. ASEI lesson is made possible through PDSI practice (Plan, Do, See, Improve).

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Such projects testify to Nigeria's acknowledgement of the need to invest in improved approaches in the teaching of maths and science through teacher quality. The role of the teacher is important in effective teaching and learning of science. Ughamadu (2005) says no matter how good a curriculum is, its success depends on the quality of teachers implementing it.

In Botswana, the Botswana General Secondary Certificate (BGCSE) science syllabus was introduced in 1997 (Yandila, Komane & Moganane, 2007). The science syllabus involves science process skills, problems solving skills and acquisition of hands-on experience (Yandila, Komane & Moganane, 2007). Science process skills include planning experiments, using and organising apparatus and materials, collecting data, handling experiments, observations and data interpretation.

Teaching calls for learner centred approaches in which learners are actively involved in learning science.

On challenges affecting science teaching in Botswana secondary schools, Yandila, Komane and Moganane (2007) discovered that teachers found it difficult to use learner centred approaches as prescribed by syllabi. Approaches such as demonstration, inquiry, practical work, project work, case studies, field trips and computer guided learning were not employed by the teachers.

Yalinda, Komane and Moganane (2007) also observe the resource limitations in science teaching in Botswana secondary schools. Laboratories were not fully equipped with the required equipment, furniture, apparatus and chemicals. Schools did not have qualified technicians and laboratory assistants. Science teaching and learning was negatively affected by shortage of required material and human resources.

In South Africa, the new democratic government sought to redress the inequalities in education caused by the apartheid system. Makgato and Mji (2006) state that the apartheid system of education was meant to suppress the potential of blacks and so the teaching of mathematics, science and technology was the most compromised. This led to the shortage of qualified teachers in these areas. The teaching of science in schools is important for the country's economic development. Ramsuran (2005) notes that because of a poor maths, science and technology base the country relies on foreign scientific and technological expertise and this is not good for any country. Human capital base should be expanded with a bias on scientific knowledge and skills.

To redress the apartheid education problems of a racially divided education system that deprives blacks of quality education, the South African government introduced Natural Science as a subject from grade 4. Mathematics, Science and Technology (MST) education have also been national priority in South Africa for several years, as evidenced, for example, by the National Strategy for Mathematics, Science and Technology Education established by the Department of Education in 2001. Such interventions have, however, necessarily produced the desired end of having scientifically literate learners. The number of Grade 12 learners who pass Physical Science and Mathematics at a higher grade, a requirement to enter into science-based studies at university, remains very low and the number of learners interested in taking Science subjects at high school is also low (Makgato & Mji, 2006).

There are concerns raised in some studies on the teaching and learning of science in South African schools (Reddy, 2004; Makgato & Mji, 2006). Some of these concerns are teacher quality, resource limitations, language of instruction, learning cultures and infrastructure in schools (Makgato & Mji, 2006). The majority of learners in South Africa being second Language speakers find themselves learning science in English and this could have an effect on the learning process. 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 and ideas. The issue of language of instruction is very important in the teaching of science. Mclean (2000) also shares the same view by saying that many of the learners learning problems in science originate from an in adequate knowledge of the basic vocabulary of the language of learning and teaching.

Knowledge of subject content is a very important attribute of an effective teacher. Darling–Hammond (2000) observes that teachers are able to teach effectively and improve students' attainment if they know very well the content of the subjects that they teach. Atilla (2007) also argues that science teachers who know their content promote scientific literacy and nurture an understanding and appreciation of science among students of all ages. Teachers should also have undergone formal training in the field in which they teach and should be well - experienced (Wayne & Younger, 2003).

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For most township and rural learners, the oral language of the school and classroom is their home language, whereas the language of reading, writing and assessment is English. The difficulty for learners is to bridge the gap and acquire not only proficiency in English, but also cognitive academic language proficiency (Cummins, 2000). These difficulties were highlighted in the report of the third International Mathematics and Science study conducted in 1999, which revealed poor English language proficiency as a cause for learners' challenges in Science and Maths.

International measures on scientific literacy have indicated that South African learners are performing poorly in science. Of the 38 and 50 countries that participated in the Trends in Mathematics and Science Study (TIMSS) in 2001 and

2003, respectively, among which were developing countries, South African learners came last in both mathematics and science (Howie, 2001). Makgato and Mji (2006) also observe that South African learners have not performed well in Science and Mathematics when compared to other learners in the world. The same is given by Villanueva (2010: 21) that:

> The findings of the Third International and Mathematics and Science Study in 1998, and the Trends in Mathematics and Science Study in 2003 (both referred to as TIMSS), revealed that of the 50 participating countries, South African grade 8 learners were the lowest scoring performers in almost all test items in mathematics and science, well below international benchmarks.

Reddy (2004) also says the South African students performed badly in international benchmark science and mathematics tests. The above shows serious underperformance in science in schools.

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Natural science in junior secondary schools is one of the subjects that teachers should pay attention to it. According to the Curriculum and Assessment Policy Statement (CAPS) document (Department of Basic Education 2011c), the instructional time in the senior phase for natural science is three hours per week, for 10 weeks per term. Six hours have been included for assessment in terms 1 and 3. Terms 2 and 4 work will cover 8 weeks each, plus 2 weeks for revision and examinations. The curriculum policy document defines science as a systematic way of looking for explanations and connecting the ideas we have. The document mentions that that science as a subject emanates from the need to understand the natural world through observation, testing and providing of ideas and has evolved to become part of the cultural heritage of all nations. Natural science is divided into four knowledge strands; life and living, matter and materials, energy and change, planet, earth and beyond.

While many research studies have looked at curriculum issues in schools in general, there is lack of research on the teaching and learning of Science in rural and remote areas of South Africa. It is the purpose of this study to fill this gap. There is often a mismatch between the planned implemented curriculum. There are concerns that school curriculum in science teaching may not be placing enough emphasis on teaching scientific skills (Broecke, 2013). This is evidenced by learners' failure to apply taught scientific skills in real life contexts. Learners' failure to take interest in studying science at high school and tertiary levels could be a result of lack of a strong foundation in the teaching and learning of science.

It is against this background that the researcher seeks to establish the implementation of the Natural Science curriculum in rural junior secondary schools in Cofimvaba education district in the Eastern Cape province of South Africa.

1.3 STATEMENT OF THE PROBLEM

The study is motivated by results of the Trends in Mathematics and Science Study (TIMSS) (2003) which showed that South African learners in grade 8 lagged behind their counterparts in other countries in the mastery of scientific knowledge and skills and application of such skills and knowledge (Villanueva, 2010). A Natural Science curriculum is offered to learners in all South African schools from grade 4 and outlines expected learning outcomes and content to be taught to learners. There is need to establish how that NS curriculum is implemented at the senior phase level of the General Education and Training band. Results of the South African National Study in mathematics and science (Reddy, 2004) further showed that Eastern Cape Province is among the lowest performers and this is a cause for concern.

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The impetus to this study is the poor performance of students in science subjects such as Physical Sciences at Matric Level (Makgato & Mji, 2006). If students' scientific literacy and interest is sufficiently developed at junior secondary school level, there would not be serious challenges in their handling of science concepts in high school. However if the science foundation is not solid, challenges of many students not taking science subjects at high school and those taking them failing will always persist (Makgato & Mji, 2006). Natural Science is not taught properly at junior levels, learners will struggle with science subjects at senior school level. Basic science skills should be developed in learners at junior secondary school level. There is a need to find out what is really happening in the classrooms. Cooper and McIntyre (1996) observe that:

> Any serious attempt to improve the quality and effectiveness of teaching and learning in schools must start from an understanding of what people in classrooms do at present.

A close understating of the implementation of the Natural Science curriculum by getting the views and experiences of teachers and learners involved in science teaching and learning will go a long way to improve the performance of learners in the subject.

The study is also motivated by the disadvantaged nature of rural schools in ensuring effective curriculum implementation. Compared to schools in urban areas, rural schools have huge operational challenges. The researcher sought to establish how an important subject such as Natural Science is taught and learnt.

It was the aim of this study to establish how the Natural Science curriculum was implemented in selected rural junior secondary schools in the Cofimvaba education district.

1.4 RESEARCH QUESTIONS

The study sought answers to the following research questions:

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1.4.1 Main Research Question

How is the Natural Science curriculum implemented in selected rural junior secondary schools in the Cofimvaba education district?

1.4.2 Sub Research Questions

a) How prepared are the teachers in the teaching and learning of Natural Science?
b) What teaching and learning methods are employed by the teachers in the teaching and learning of Natural Science?
c) What are the challenges encountered in the teaching and learning of the Natural Science Curriculum?
d) How can the teaching and learning of Natural Science be enhanced to promote scientific literacy in learners?

1.5 PURPOSE OF THE STUDY

The purpose of the study was to establish how the Natural Science curriculum is implemented in selected rural junior secondary schools in the Cofimvaba Education District.

1.6 OBJECTIVES OF THE STUDY

The study sought to address the following research objectives:

1.6.1 To ascertain the preparedness of teachers in the teaching and learning of Natural Science.

1.6.2 To establish the teaching and learning methods employed in the teaching and learning of Natural Science.

1.6.3 To identify challenges encountered in the teaching and learning of Natural Science.

1.6.4 To suggest how the teaching and learning of Natural Science can be enhanced to promote scientific literacy in learners.

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1.7 RESEARCH STRATEGY

Table 1 gives a brief description of the research plan of action whose details are given in chapter three of the study.

Table 1- Study plan of action

Guiding Research Question	
How is the Natural Science Curriculum implemented in selected rural junior secondary schools in the Cofimvaba Education District?	
Paradigmatic Suppositions	
Epistemological Models	Constructivism and Interpretivism
Methodological Model	Qualitative Approach
Research Design	
Case Study	
Selection of Participants	
Purposive Sample	Three School Principals Three Natural Science Teachers Eighteen Grade Nine NS Learners

Data Collection	
Data Collection Methods	Individual Interviews with Principals and Teachers Focus Group Interviews with Learners Lesson Observation of Three Natural Science Lessons
Data Analysis and Interpretation	
Data Analysis Method	Content Analysis, Transcribing Data, Forming Meaning Units, Condensing Meaning Units, Categorizing and Theming
Data Trustworthiness	
Aspects of Trustworthiness Attended to.	Credibility, Transferability, Dependability and Confirmability
Ethical Considerations	
Ethical Elements attended to.	Research Permission, Informed Consent, Confidentiality And Anonymity.
Conclusions	
Recommendations	

1.8 SIGNIFICANCE OF THE STUDY

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The study is of significance to various stakeholders. The study is expected to identify the content gaps in the educators' subject matter knowledge which would help district education officials to plan relevant intervention measures. The district office will benefit as they will be able to arrange strategies needed to help educators who perform badly. The district officials will be able to close the content gap by organising workshops for educators, so that they can be able to deal with challenges they encounter. The study is also expected to identify challenges that are faced by the teachers in the teaching and learning of NS, and teachers will benefit too, as they will be able to develop themselves and become motivated in teaching the subject. They will also correct mistakes they are doing when implementing the curriculum e.g. approaches they used and methods. There will be team collaboration and progress in schools that will enhance good quality results. The findings of the study could also help the department of education to improve pass rate in Eastern Cape. The learners will be motivated with the new strategies that will lead to involve them more in the classrooms because they will be able to do practical work supported by both parents and teachers. When parents work with school they make a difference, because they assist learners in all dimensions.

1.9 DELIMITATION OF THE STUDY

The study focused on three rural junior secondary schools in Cofimvaba district in Eastern Cape. It specifically looked at the implementation of the Natural Sciences curriculum at the senior phase level of the General Education and Training band. The study was confined to teachers and learners involved in the implementation of the Natural Science curriculum in grades seven, eight and nine shall be targeted.

1.10 DEFINITION OF KEY TERMS

The following terms pertinent to the study are defined:

Table 2: Definition of key terms

TERM	DEFINITION
Curriculum	Lovat and Smith (2003) defines curriculum as a plan for learning. In this study curriculum shall be taken to mean the planned content, learning outcomes, materials, teaching, learning and assessment approaches in science.
Curriculum implementation	Ornstein and Hunkins (1993) define curriculum implementation as the operationalisation of a planned curriculum. In this study curriculum implementation shall refer to teaching and learning processes.
Junior secondary schools	Schools in the South African education system that offer tuition to learners from Grade R to Grade 9.
Teaching	activities necessary for the facilitation of learning
Learning	Learners' active engagement with content and materials
Natural Science	The Collins English Dictionary (2009) defines natural science as a science or knowledge of objects or processes observable in nature such as biology, chemistry and physics. In this study Natural Science refers to a subject in the SA education system teaches in which learners learn combined science
Rural school	Johnson and Strange (2007) define rural schools as small and isolated in deprived geographical locations sparse population

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	can make networking and delivery of effective provision problematic. In this study rural shall simply mean a school located in an area out of town or city.
Scientific literacy	The United States Centre for Education Statistics (2005) defines scientific literacy as "the knowledge and understanding of scientific concepts and processes required for personal decisions-making, participation in civic and cultural affairs, and economic productivity." In this study scientific literacy shall be taken to mean mastery of scientific concepts and processes and the ability to apply them to solve problem

1.11 CHAPTER OUTLINE

The study is organised into five chapters as follows:

Chapter 1: Introduction and Background.

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Chapter 2: Literature Review

Chapter 3. Research Methodology

Chapter 4. Data Presentation, Analysis and Discussion

Chapter 5: Summary, Conclusions and Recommendations

1.12 SUMMARY

This chapter contextualised the study at international, African, and South African levels. The chapter also covered the statement of the problem, research questions, purpose of the study, objectives of the study, research strategy, significance of the study, delimitations of the study, conceptualisation of the terms. The next chapter will discuss the theoretical framework which informs the study and also review literature relevant and related to the study.

CHAPTER TWO

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 INTRODUCTION

The previous chapter provided a detailed background to the study. The purpose of this chapter is to discuss the theoretical framework underpinning the study, as well as analytically review literature pertinent to the study. The social constructivist theory, which informs the study, is discussed first. Areas of literature responsive to the study's research questions reviewed include the importance of science as a subject, appropriate methods in science teaching, importance of teacher training, learners' interest and science learning, learners background and learning of science, resources and science teaching and learning and previous studies on science teaching and learning.

2.2 THEORETICAL FRAMEWORK

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This section looks in some greater detail what theoretical framework is and its importance in a research study. The social constructivist theory on which the present study is underpinned shall also be discussed.

2.2.1 What is a theoretical framework in research?

According to Swanson (2013), a theoretical framework is the structure that can hold or support a theory of a research study. Swanson (2013) further says a theoretical framework introduces and describes the theory that explains the research problem under study. Similarly, Denzin and Lincoln (2000) posit that a theoretical framework shows and guides the beliefs and researcher's worldview. This shows that the problem in a research study should be informed by theory. The study sought to establish participants' views on the implementation of the Natural Science curriculum and a relevant teaching and learning theory had to inform it. Denzin and Lincoln (2000) further reveal that a theoretical framework is the position a researcher takes in accounting for knowledge interpretation and knowledge making. In interpreting and discussing findings for the study, the researcher was guided and informed by the chosen theory called social constructivism.

2.2.2 Importance of theoretical framework in research

In explaining the importance of a theoretical framework in research, Maxwell (2005:123) states that:

> ... the point is not to summarize what has already been done in the field. Instead, it is to ground your proposed study in the relevant previous work, and to give the reader a clear sense of your theoretical approach to the phenomena that you propose to study.

It is therefore, important to ensure that a research study is underpinned by theory as theory shows how research fits into what is already known thereby establishing a relationship to existing theory and research. It also shows how one's research study makes a contribution to the phenomenon under study. Maxwell (2005:214) notes that:

> A useful theory also illuminates what you are seeing in your research. It draws your attention to particular events or phenomena and sheds light on relationships that might otherwise go unnoticed or misunderstood.

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A theoretical framework, therefore, provides the lens through which the research study is viewed and assists in better understanding the phenomenon under study. This is consistent with the view advanced by McGaghie, Bordage and Shea (2010:923) that theoretical framework always underlies a research study.

A theoretical framework provides a link among all the major aspect of a research study. Ennis (1999:129) observes that a theoretical framework:

... is a structure that identifies and describes major elements, variables, or constructs that organise your scholarship. It is used to hypothesise, understand or give meaning to the relationships among the elements that influence affect, or predict the events or outcomes. 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 is theory and how it informed the study.

2.2.3 The Constructivist theory of learning

Since the study is about teaching and learning, the constructivist learning theory informed it. Constructivism states that learning happens when learners construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences (Vygotsky, 1985). Zhu, Ennis and Chen (2011) identify the key features of constructivist theory of learning which are that:

- The learner is actively engaged in learning
- The learner's experiences are important in learning
- The learner personally constructs meaningful understanding of concepts
- Social and cultural contexts are important in learning
- The teacher constructs learning tasks utilising learners' experiences

The theory suggests that knowledge is a human product constructed in a social and cultural context and appropriated by individuals (Bruning, Schraw & Ronning, 1999). According to social constructivists, the process of sharing individual perspectives, which is called collaborative elaboration (Ernest, 1999), results in people constructing understanding together that wouldn't be possible alone.

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A social constructivist viewpoint has both the instructor and the learners learning from each other (Holt & Willard-Holt, 2000). Constructivism also links with the interpretive ontological assumption that reality is socially constructed by humans through their action and interaction (Andrade 2009). According to Mingers (2001) social constructionism has its roots in phenomenology.

Constructivism applies to science teaching and learning, because the theory encourages learning based on active techniques such as experimentation and problem solving. The role of the teacher is to facilitate learning by providing materials, resources and tasks to ensure that learners engage in learning. In investigating factors affecting the teaching and learning of Natural Science, the role of the teachers, learners and resources was considered as informed by the constructivist theory of learning. The constructivist view of learning informs a number of different teaching practices, like encouraging students to use active techniques to create more knowledge and then reflecting on what they are doing and how their understanding is changing.

In the constructivist classroom, the focus tends to shift from the teacher to the students. The classroom is no longer a place where the teacher pours knowledge into passive students, who wait like empty vessels to be filled. In this theory, students are actively involved in their own process of learning. The teacher is a facilitator who coaches, mediates, prompts, and helps students develop as well as assess their understanding. Vygotsky argues that students are not blank slates but come to the learning situation with already formulated knowledge, ideas and understandings. The prior knowledge is the raw material for the new knowledge learners create.

A constructivist model currently serves as a theoretical organiser for many science educators who are trying to understand reasoning in science (Lunetta, 1998). In this way, learners should be able to construct their ideas and understanding on the basis of series of personal experiences. Learning becomes an active, interpretive and interactive process (Tobin, 1990). Learning is placed in meaningful contexts and learners construct knowledge by so[illegible] and meaningful problems (Polman, 1999). Tytler (2002) argues that to develop a new understanding there is need for learners to be encouraged to extend their prior knowledge to a new situation. Tytler (2002:30) asserts that:

> If we believe that knowledge is highly contextual, and that the fundamental difficulty in developing new understandings is extending them to new situations, then we need to plan for students to be exposed to a range of situations in which a particular science insight can be used. This would imply, for instance, that one-off activities followed by discussion are ineffective. Students need to be explicitly helped in extending new ideas to different situations as part of the conceptual change process.

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The study conceives constructivism as a theory that helps teachers to understand how their students learn and guides their teaching practice in order to make it easy for learner to share their experiences and participate actively.

The three most influential constructivist models in science education are the generative learning model (Cosgrove & Osborne, 1985; Osborne & Wittrock, 1983), the interactive learning model (Biddulph & Osborne, 1984), and the 5Es instructional model (Bybee, 1997).The generative model of learning (Cosgrove & Osborne, 1985) describes how children learn and how to teach children. The model consists of four phases, the preliminary, focus, challenge and application. The preliminary phase is characterised by the teacher determining the prior knowledge that students might bring into the learning environment that is relevant to the new topic. Some researchers claim that students' prior knowledge and experiences have a powerful influence on their new knowledge and understanding (Goodrum, Hackling & Rennie, 2001).

The focus phase deals with the activity that students engage in that makes explicit, the range of students' existing beliefs related to the new concept. The challenge phase is characterized by students comparing the scientific explanation with their own ideas and those of other students through debate and testing each other's ideas and so on. The final phase is the application phase during which students determine whether the concept could be useful and applicable to a variety of situations.

The second model, the interactive learning approach (Biddulph & Osborne, 1984) consists of five phases namely: preparation, exploratory activities, students' questions, students' investigation, and reflection. The preparation phase is the first stage in which the teacher explores students' prior knowledge about the topic and then organises resources together with the students. The next phase, exploratory activities, involves the teacher asking students questions and encouraging discussion among the students in order to arouse their curiosity of the topic with a view to gaining insight into what ideas or prior knowledge the students have about the topic. Students' questions phase is primarily concerned with asking and clarifying of questions by the students.

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The students' investigations phase focuses on the teacher helping the students in planning and conducting investigations based on the questions chosen through experimentation, reading of articles or books, writing of letters asking for information or consulting with experts. The final phase is reflection, during which students are helped by the teacher to record, evaluate and reflect on the results of the investigations and the strategies they employed. Students are also encouraged to ask more questions, share, discuss and evaluate their findings with other students

The second model, interactive learning approach consists of five phases namely: preparation, exploratory activities, students' questions, students' investigation and reflection (Biddulph & Osborne, 1984). The preparation phase is the first stage in which the teacher gains the previous knowledge and ideas that students have about the topic and then organises resources together with the students.

The next phase, exploratory activities involves the teacher asking students questions and encourages discussion among the students in order to arouse their curiosity of the topic with a view to gain insight into what ideas or prior knowledge the students have about the topic. Students' questions phase is primarily concerned with asking and clarifying of questions by the students. The students' investigations phase deals with the teacher helping the students in planning and conducting investigations based on the questions chosen through experimentation, reading of articles or books, writing of letters asking for information or consulting with experts. The last phase is reflection during which students are helped by the teacher to record, evaluate and reflect on the results of the investigations and the strategies they employed (Biddulph & Osborne, 1984).

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The third model, the 5Es instructional model (Bybee, 1997), consists of five phases; engagement, exploration, explanation, elaboration and evaluation. In these phases, learners' interests are promoted and motivated in order to arouse their curiosity, and are allowed to question the views of others. The learners are afforded the opportunity to explain their findings on a task and evaluate their procedure in order to see if the purpose has been realised.

Constructivist approaches to science teaching are analogous to what scientists do in that they are inquiry-based and offer science teachers the opportunity to fulfil the constructivist promise of improved teaching and learning (Lorsbach & Tobin, 1998; Tam, 1999). A major criticism of the constructivist approach is that it requires more time for exploring and negotiating understanding with students (Tytler, 2002).

Constructivism is an approach in which teachers and learners engage in discourse and problem-solving activities with a view to generate and promote new information (Brooks & Brooks, 1993). Thus, for teachers to successfully implement constructivist-teaching approaches in their classroom, they need the support of professional development and new curriculum materials (Venville, Wallace & Louden, 1998).

2.2.3.1 The more knowledgeable others and zone of proximal development

One of Vygotsky' (1985) most important theory is the "zone of proximal development." He posits that children, in any given domain, have actual developmental levels, which can be assessed by testing them individually. He further states that there is an immediate potential for development within each domain.

The difference between the actual and the immediate potential development zone is called the zone of proximal development. It is suggested that the distance between the actual developmental level as determined by independent problem solving, and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers, which are too difficult for children to master alone, can be learned with guidance and assistance from adults, more-skilled children, or more knowledgeable others. Vygotsky further states that cooperative learning is important and proposes five principles that should guide the development of the lesson, namely: positive interdependence, individual accountability, face to face promotive interaction, appropriate use of social, interpersonal, collaborative and small group skills, and group processing (Slavin, 1990).

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In individual accountability, the students are expected to be accountable to other group members and must contribute to the group success Slavin (1990). Learners must be given a chance to be accountable and, for example, they must organise the needs for the group on their own. They must also be accountable for the poor their performance in the task performed. In face to face promotive interaction, group members help each other by supporting, encouraging one another Slavin (1990), for learning to be effective, learners must learn to support each other for the success of group and other learners will also develop confidence when presenting in groups. Slavin (1990) further underscores the importance of the appropriate use of social, interactive, cooperative and small – group skills. Students are encouraged and helped to develop and practice trust- building, leadership, decision making, communication and conflict management. Every learner in the project has a task to perform. Johnson and Johnson (1999), Johnson, Johnson and Holubec (1991) posit that in the group processing model, team members set group goals and assess their performance as a team and institute strategies' to change if they are not functioning well.

Social constructivism also places emphasis on group process in learning. In group process, team members set group goals, describe what member actions are helpful or not, periodically assess what they are doing well as a team and identify changes they will make to function more effectively in the future (Johnson & Johnson, 1999; Johnson, Johnson & Holubec, 1991). Learners learn to perform tasks in groups by assuming and taking responsibility for their learning. Johnson and Johnson (1999) focus on developing a specific structure that can be incorporated into a variety of curricula, with an emphasis on integrating social skills with academic activities. From NS teacher interviews and classroom observations the study hoped to uncover cooperative learning strategies employed by teachers to deliver, to enhance quality and develop independence in learners.

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2.3 THE IMPORTANCE OF SCIENCE AS A SUBJECT

Scientific knowledge pushes economic and technological development and so the importance of Science teaching cannot be over emphasised. The teaching of science subjects in schools is very important for the economic development of a country through the promotion of scientific knowledge. Ogunniyi (2007) argues that Africa should develop its scientific human power to become self-reliant in the production of goods and services hence the importance of a strong emphasis on effective teaching of science subjects in schools. In South Africa, the creation of a Ministry of Science, Technology and Culture shows government's commitment to the use of science to promote economic development.

Learners should learn science to develop scientific literacy. The OECD (2003:12) defines scientific literacy as:

> An individual's scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence based conclusions about science related issues, understanding of the characteristic features of science as a form of human knowledge and enquiry, awareness of how science and technology shape our material, intellectual and cultural environments.

Through scientific literacy, a learner develops in-depth knowledge of science and skills to undertake scientific investigations and derive conclusions. A learner should be actively involved in the learning of science through conduct of experiments and knowledge gained should be applied to solve related scientific problems. Science teaching should not lead to content memorisation. Learners should be able read, write and talk science (Yore & Treagust, 2006).

In science education, students are being brought up as scientifically literate individuals and that is considered as one of the most important educational objectives (Moss, Abrams & Robb, 2001).Moss, Abrams and Robb (2001) further note that scientific literacy is linked to the understanding of the processes of scientific inquiry and nature of science (NOS). Science develops individuals who are conscious consumers of scientific knowledge, sensitive to social issues, participants in decision making processes, and appreciative of science as a part of contemporary culture (Hanuscin & Hian, 2009).) According to Akerson and Hanuscin (2007) teachers' beliefs about NoS influence [illegible] perceptions, teaching practices and students' perceptions). The South African Department of Education (DoE, 2011c) asserts that the underpinning philosophy of Natural Science learning Area is to promote scientific literacy through the development and application of scientific knowledge and understanding and the appreciation of the relationships and responsibilities between science, society and the environment.

Many nations around the world have called for reform in science education for more than a decade, and shared some reform ideals (Van Driel, Beijaard & Verloop, 2001). Most such reform emphasizes social constructivist teaching approaches (Garm & Karlsen, 2004). That is why Vygotsky mentions key features of constructivist theory e.g. the importance of learners' active engagement in learning, leaners' experiences, social and cultural contexts. The role of language in science is very important. According to Simala (2001: 311) language makes it possible for us to understand and make sense of the world of science by providing a cognitive framework for concepts. It is through the use of such a framework that concepts are interpreted and information exchanged. The Department of Education (2011c) notes that:

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The science knowledge we teach at school is not in doubt – most of it has been tested and known since the 1800s –but a good teacher will tell the learners something of the arguments and confusion among the people who were first to investigate. Science also explores the frontiers of the unknown. There are many unanswered questions such as: Why is climate changing around the world? What is making the universe expand? What causes the earth's magnetic field to change? As with all knowledge, scientific knowledge changes over time as scientists acquire new information and people change their ways of viewing the world.

Careful selection of content, and use of a variety of approaches to teaching and learning science, should promote understanding of science as a discipline that sustains enjoyment and curiosity about the world and natural phenomena and the history of Science and the relationship between Natural Sciences and other subjects. It should also promote the need for using scientific knowledge responsibly in the interest of society and the environment.

Natural Sciences at the senior phase level lays the basis for further studies in more specific Science disciplines, such as Life Sciences, Physical Sciences, Earth Sciences or Agricultural Sciences. It prepares learners for active participation in a democratic society that values human rights and promotes responsibility towards the environment. Natural Sciences can also prepare learners for economic activity and self-expression. Scientific literacy is nurtured by quality science education. Research in a range of countries has clearly shown a positive correlation between high scientific literacy and the level of general education attained (Pardo & Cavo, 2004). Formal education can provide basic scientific literacy for students in preparing for the workplace. However, science education in schools can hardly satisfy the needs of the general public towards improvement of their scientific literacy. Informal and non-formal science education is also an essential component of lifelong learning. Furthermore, widespread scientific literacy is also a vital element in gaining public support for continuing advances in scientific disciplines (Duckworth, 2006). Formal education develops learners to be critical thinkers and what they learn from NS, they will be able to plough back in their communities and the public will support them.

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Research in a range of countries has clearly shown a positive correlation between high scientific literacy and the level of general education attained (Millar, 2002). Formal education should provide basic scientific literacy for students in preparing for the workplace. Education will assist to mould learners for the world of work, as science deals mostly with research, then the learners will be able to work as scientists and the formal education must prepare the learners with skills that will help them (Duckworth, 2006) Hence the importance of the study in establishing ways to enhance the teaching and learning of science in order to promote scientific literacy in learners.

2.4 SCIENCE TEACHING APPROACHES

Science teaching is characterised by a multiplicity of approaches (Duckworth, 2006). Use of different approaches in teaching science helps to accommodate learners with challenges. Cimer (2007) observes that there are six principles of effective teaching of science which act as teaching approaches that allow learners to construct their own understanding and knowledge. Cimer (2007) further states that these principles, which contribute to effective teaching, derive from constructivist ideas in teaching and learning.

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The first principle involves dealing with learners' existing ideas and conceptions. Tytler (2002) notes that learners' existing ideas and conceptions have been identified as valuable considerations in science teaching and a necessary part of teaching strategies. Tytler (2002) observes the common belief that learners do not arrive in the classroom as empty vessels into which new ideas can be poured by teachers hence teachers should utilise learners' prior knowledge. Tytler (2002) further observes that learners' existing ideas and conceptions in science increase students' awareness of them. In this principle, there are teaching methods that can be used to make a lesson successful not by just presenting information to learners directly from the text but by providing demonstrations and activities. This is the learner-centred aspect of the constructivist view of learning. Amos and Boohan (2002) observe that the question and answer method is the most common method used to stimulate learners and expose their informal, and perhaps distorted, preconceptions developed through their everyday experiences to facilitate their recalling ideas from their long term memory. Amos and Boohan (2002) note that multimedia can help teachers bring the real world to learners through the use of sound and videos. Nayar and Pushpam (2000) also report that when teachers integrate appropriate media in the curriculum, their students achieve significantly higher learning outcomes. It was the purpose of the present study to establish approaches and techniques employed by teachers in science teaching and learning. The researcher is of the opinion that using different approaches learning will be enhanced.

The second principle encourages learners to apply new concepts or skills into different contexts. Effective learning requires learners to apply newly acquired concepts or skills to different contexts (Gallagher, 2000). This potentially leads to higher learning outcomes and application of knowledge or skills to solve everyday problems. Gallagher (2000) suggests that teachers should make the teaching and learning of science concepts relevant to the learners' lives by bringing in real life examples where possible. Gallagher continues by saying teachers can employ various methods to help learners to apply their knowledge such as conducting practical work, field trips, and doing role play.

The third principle is based on encouraging student participation in lessons. Research shows that the more learners are involved in the learning process, the more they learn (Trowbridge, Bybee & Powell, 2000). Many different methods and strategies have been suggested for involving learners in lessons and engaging them in active learning (Trowbridge, Bybee & Powell, 2000; Deboer, 2002; Goodrum, Hackling & Rennie, 2002). Amos and Boohan (2002) advocate questioning and role playing. This shows that teachers should be aware of the different teaching approaches that make it possible to involve learners actively in science learning.

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According to Cimer (2007), the fourth principle is encouraging student enquiry. Trowbridge, Bybee and Powell (2000: 207) define inquiry as "the process of defining and investigating problems, formulating hypotheses, designing experiments, gathering data and drawing conclusions about problems". Through scientific inquiry, learners are not passive receivers of information but actively engage with content to derive meaning out of it. The role of the teacher, in this regard, will be to facilitate learning. Trowbridge, Bybee and Powell (2000) further suggest that teachers use less question-answer dialogue but organise more class time for student questions, student individual and group reports, whole class and small group activities.

Encouraging co-operative learning among students is another principle of effective science teaching. Encouraging learners to work or co-operate with each other in constructing their own understanding has been a highly valued principle of effective teaching in science (Munro, 1999). In co-operative learning, the method that can be used is peer or group learning, where peers can moderate each other's learning in ways that are distinctively different from the teacher's method (Jones & Carter, 1998).

Offering continuous assessment and providing performance feedback is also another important principle. Effective teaching requires teachers to check continuously students' understanding and give detailed positive feedback which helps students correctly integrate new knowledge into an existing knowledge structure (Cimer, 2007). The methods that can be used according to Cimer (2007) are formative assessment and self-assessment. Amos and Boohan (2002) argue that use of higher order questions enable learners to apply, analyse, synthesise, and evaluate information, which were considered as high order thinking skills in Bloom's taxonomy of educational objectives (Bloom, 1956).

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In the past, considerable attention has been devoted to the improvement of primary science education. As a result of research advocating inquiry-based education, inquiry based science teaching and learning has become the focus in policy documents (Luera & Otto, 2005). Research illuminates the many pedagogical, organizational and didactic difficulties teachers face in providing inquiry-based education (Kim & Tan, 2011). Teachers need competencies to guide the inquiry process. Poor or insufficient guidance and feedback be offered during the instructional process negatively affects learning (Kirschner, Sweller & Clark, 2006). Alarke – Tuanter, Biemans, Tobi, Wals, Oosterheert, and Mulder (2012) identify twenty three elements of competencies. These competencies were categorised in the groups' subject matter knowledge (SMK) elements, pedagogical content knowledge (PCK) elements, and attitude elements.

2.4.1 Inquiry Based Science Education

Liang and Richardson (2009) define scientific inquiry as the diverse ways in which scientists study the natural world. Scientific inquiry involves a complex activity that involves "observations, posing questions, examining books and other resources of information to see what is already known, planning investigation, reviewing what is already known in the light of experimental evidence, using tools to gather, analyse and interpret data, proposing answers, explanations and predictions and communicating the results” (National Research Council, 1996:23). Scientific inquiry derives its basis from inquiry-based education which is born out of a mixture of the works of Jean Piaget, Lev Vygotsky and David Ausubel, within the philosophical nature of learning and teaching known as constructivism (Liang & Gabel, 2005). The constructivist approach emphasizes that phenomenology is constructed through active thinking, the organization of the information and the integration of existing knowledge. Teachers need specific inquiry-based science teaching competencies to support and facilitate students’ learning (Kirschner, Schweller & Clark, 2006). Teachers are supposed to use inquiry-based science competencies through experiments, problem solving and building upon learners’ prior knowledge.

Inquiry instruction in science enables learners to formulate their own questions, devise ways to answer them through data collection and analysis and then determine the reliability of the knowledge acquired (Ackerson & Donnelly, 2010). Scientific inquiry involves students “doing scientifically” through investigating, understanding and communicating (Hackling & Fairbrother, 1996). Literature in science education describes three levels of inquiry-based teaching and learning. These are structured inquiry, guided inquiry and open inquiry (Afonso & Gilbert, 2010).

Afonso and Gilbert (2010) describes structured inquiry as one that involves the teacher engaging students in problem-solving activities and providing them with procedures and materials to allow them to discover and generalize from data collected. Learners are given a task to apply their critical thinking in order to solve a problem. In the guided Inquiry approach, the teacher provides materials and problems to be investigated while the students manipulate the materials and solve the problem on their own (Hackling & Fairbrother, 1996).

Afonso and Gilbert (2010) as well as Hackling and Fairbrother (1996) note that in an open inquiry approach, students formulate their own problems to investigate. This means that students are able to come up with their problems and also solve them on their own. This study sought to understand the approaches employed by teachers in teaching NS meaningfully in rural contexts. The assumption was that science

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teachers were aware of the different teaching approaches and were adequately prepared to teach the subject.

2.4.2 Other Teaching and Learning Approaches

There are different specific teaching and learning techniques that teachers can employ to ensure meaningful teaching of Science in schools. Hudson (2007) talks of the use of buzz groups, where group members participate in small sub-groups, and then take part in a discussion with the entire group, every group member is expected to participate and work together with other group members. Each group is expected to choose a leader who will be responsible for reporting the important ideas discussed in the group to the whole class, Hudson (2007). In using buzz groups, the teacher should be aware of the importance of developing group members' self-esteem in the subject when they report back to the whole class. Teaching and learning is enhanced because learners learn from their peers.

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According to Hudson (2007) another method is the use of panels, in which a selected group of learners with a leader talk about an issue in front of an audience, which is later incorporated. It is a technique that stimulates interest and thinking and provokes discussion. In this method the leader plans the conversation with the four to six panel members each of whom is given a specific topic to study. The panel discusses the topic informally without set speeches. In science teaching and learning, such an approach helps in boosting learners' confidence in talking about scientific issues. The leader opens the discussion to the group and summarizes what others have said. This technique is interesting because the audience attends carefully and critically in order to make a meaningful contribution when they eventually join in.

Symposia are another method where a topic is broken into various parts with each part presented by an expert or well-informed person in brief .The facilitator meets with three or four group members and plans an outline. Participants are introduced and given reports. The group questions the speakers. The facilitator summarizes what has been said (Hudson, 2007). This technique empowers learners to deal with science concepts rather than only listen to the teacher. It promotes team collaboration and enhances learners' understanding of concepts. There are many skills that are sharpened by this technique such as debating, presentation, team work, independence, research and writing skills.

Through the use of debates, learners discuss controversial issues supporting their different viewpoints. The purpose of the participants is to convince the audience rather than to display skill in attacking the opponent. If a controversy exists on which there are fairly definite opinions on both sides, debates can bring these differences out in the open in a friendly manner. In this technique groups are divided into sides. Each speaker should be limited to a predetermined amount of time, followed by time for rebuttal if desired (Hudson, 2007). This is a skill that develops the learners holistically because learners are supposed to defend the topic and come out with good points. The learners employ evaluation and analytical skills to argue against or for the topic.

Another technique is experience discussion, small or large-group discussion, which takes place following a report on the main point of a book, article, or life experience. It is used to present a new point of view of an issue; to stimulate thought and discussion; and also in an open discussion on pertinent issues (Hudson, 2007). The researcher highlight that this method is also important because it can be used in pertinent issues like the load shedding, that means learners will think scientifically like the issue of renewable and non-renewable resources and how to economise them. They will suggest other ways that can be used to boost electricity. This method enhances and develops learners' thinking skill.

In case studies, an actual account of a particular incident and/or problem is presented to the class – including how the matter was resolved. This method is often used to supplement traditional lectures. It can also be used to synthesize ideas and to apply theory to practical problems. The facilitator documents a case study, altering actual names and places if required. The case study is presented to the class, and is generally followed by discussion (Hudson, 2007). This technique benefits learners who are good in theory but are reserved in presentation.

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Jigsaws are a technique in which, according to Hudson (2007), all group members participate as both experts and learners. This is often followed by a problem-solving situation where all the knowledge must be used for the group to succeed. Students work in small groups (expert groups) to master the material. The facilitator rotates among the groups to answer questions and make sure the material is being mastered and understood. Students return to their home groups, which include one member from each expert group. They teach each other their areas of responsibility and then use the new knowledge to solve a problem, write a group essay or examination. In this technique all the learners become experts. It promotes responsibility and attentiveness as learners have to explain to their home group.

The purpose of this study was to ascertain the teaching approaches employed by teachers in teaching different NS topics. The assumption was that a trained teacher who is a science specialist is prepared to teach the subject using different teaching and learning approaches and ensuring that learners understand the concepts taught. In line with social constructivist approaches, the researcher was also interested in establishing how learners were involved in the actual learning of science by actually participating as individuals and as groups.

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2.4.3 Attitudes and Science Teaching and Learning

Interest in learning increases when positive attitudes are developed (Hevedanli & Akbayin, 2006). Ekici (2008) observes that in order for learners to form positive attitudes the instructional process should take into account the methods, techniques, teaching aids and strategies which are compatible with their learning styles. If prospective teachers can be trained in a way that they develop positive attitudes, they do their job in a committed way, derive pleasure from it and fulfil their responsibilities and roles effectively (Celikoz & Metin, 2004). However, a teacher who has developed negative attitudes will reflect this negativity on his/her behaviours and in this case, the education system, especially learners, will be negatively affected (Cetinkaya, 2009). Semerci and Semerci (2004) define negative attitudes as a lack of motivation in loving the students, improving yourself and being enthusiastic and willing. Kahyaogly and Yangin (2007) as well as Ekici (2008) observe that education is an important tool in changing attitudes. The researcher agrees with the above researchers in that if the teacher lacks knowledge in the subject, he will be compromised in instructional effectiveness. It is, therefore, important for educators to educate themselves so that they can be able to work confidently. In South Africa learners' lack of interest in studying sciences is also common and one of the causes is the poor way in which science is taught (Furió-Más, Solbes & Furió-Gómez, 2008). This could be caused by lack of proper teacher training (Furió-Más, Solbes, Furió-Gómez, 2008). Science teachers require proper training and professional support to ensure effective teaching of the subject in a way that stimulates learners' interests.

Research on prospective primary teachers has shown that there are differences between emotions experienced by men and women when teaching physics and chemistry (Brigido et al, 2013; Fernandez, Brigido & Borrachero, 2013). Men express more positive emotions towards teaching physics and chemistry than women, and the latter express more negative emotions (Brigido et al, 2010). A study carried out in Australia by Ritchie et al (2013) found that teachers own classroom experiences as learners, together with their expectations produce positive or negative emotional states that condition their teaching behaviour. Bisquerra (2005) argues that it is necessary for teachers' education to provide them with strong skills on dealing with learners' emotional needs. This enables teachers to handle the complex nature of teaching (Costa, 2002; Extremera & Fernandez- Berrocal, 2006). Mearns and Cain (2003) note that teachers who are able to deal with children's emotional needs may also be able to use strategies to cope with stressful situations in their classes.

With regard to science teaching, some science teachers feel poorly qualified to teach science, considering their scientific knowledge to be insufficient (Perandones & Castejon, 2007). They may believe that science subjects are difficult to teach and may have a sense of insecurity in facilitating the learning of science (Perrenoud, 1996). Teachers with little confidence are sensitive to the anxiety associated with failure because they view their teaching as an ongoing threat (Brigido et al, 2013). Reddy (2006) also notes that a fundamental challenge to advancing science education in South Africa is improving the quality of the science teachers being produced, as well as developing in-service science teachers. On the whole, primary educators lack the necessary confidence and knowledge of science (Fensham, 2008; Taylor & Vinjevod, 1999) and the anxiety or apathy towards science amongst school teachers may be attributed to several key factors. It was vital for this study to

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establish teacher quality in science teaching by talking to teachers and observing them teach Science.

Attitude towards science and science education can be defined as the favourable or unfavourable feelings and beliefs about science as learning and teaching subject (Fensham, 2008). Attitude toward science and science teaching involves the importance one attributes to science and to science teaching. Secondly the experienced pleasure or anxiety, thirdly the perceived nature of science, fourthly, teachers' sense of science teaching self-efficacy and lastly the attitude toward competence development (Kahyaogly & Yangin, 2007). Teacher's sense of confidence plays a major role in their classroom behaviour, such as how they approach goals, tasks and challenges (Bandura, 1997).

The changing face of teaching has moved away from didacticism to learning facilitation and with this is the need for teachers to play different roles and use new techniques (Jarvis, 2002). Three main styles of teaching are; didactic, Socratic and facilitative. The diversity of styles provides a degree of flexibility that allows one to alter the task of teaching whether it is teacher-centred or student-centred. Jarvis (2002) views teaching as both an art and a science. Teaching is flexible and teachers should use different methods and techniques to enhance learning and refrain from traditional teacher centred and telling methods. The teacher must be able to link content to learners' daily lives and not treat it in isolation.

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Didacticism raises numerous constraints which involve rote learning, learning by note taking, and potential boredom as the approach limits student participation and reflection. Many traditional lecturers continue to use the lecture as a means of teaching, especially when the subject is new to the majority of students or if the students are teacher dependent, anxious or disorganised as learners (Walkin, 2000). Although all approaches have their place in teaching and learning, currently learner centeredness is preferred. In NS the teacher must not concentrate on the telling method since The Department of Basic Education (2011c) states that in science, investigations must be done, experiments must be conducted and projects must be undertaken.

The Socratic method of teaching also emphasises student-centredness and strongly opposes didacticism. Brownhill (2002) illustrates how teachers can use either authoritarian or non-authoritarian Socratic teaching positions to enable students to learn independently and become critical thinkers. Teachers provide the initial theoretical positions and introduce the associated inconsistencies and attributes in an attempt to raise awareness in students, initiate reflection and ponder on the key concepts. Both autocratic and non-autocratic teaching approaches equally enhance the ability of students to conceptualise and reflect on positions. In Natural Science learners are expected to do hands on activities, teachers provide theory at the same time hands on must be done. Learners can come with a problem and solve it on their own.

Critical pedagogy is the most effective style of facilitation, as it hands over the responsibility for learning to the learners and to think critically on scientific issues studied as well as study them in context (Ramesh & Patel, 2013). Critical pedagogy can be used in teaching science to improve the performance of learners and to make the lesson interesting, and will also assist teachers to identify the approach that suits the environment they are working in. This allows learners to work in groups and link the new science concepts to what the learners already know. The study sought to understand the extent to which the critical pedagogy is it really applied in the rural context so as to improve the learning of NS in the rural schools. In addition the study wants to know the teaching and learning methods employed in the teaching of natural science.

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2.5 TEACHER PREPAREDNESS IN SCIENCE TEACHING

Achieving quality education for all, in line with goal 6 of the Dakar framework for action, calls for more and better trained teachers as pedagogical processes lie at the heart of quality education. The South Africa Department of Basic Education plays a pivotal role in training teachers to be able to unpack the content for learners. The subject advisors conduct workshops to close content gap, even during implementation of CAPS, they were more involved. There are non-governmental organisations that work with the department of education to enhance the level of Science and Mathematics.

Muwanga-Zake (2001:1) states that a survey, carried out in Eastern Cape schools, showed that teachers had challenges in teaching science and that:

> ...the teachers' problems, such as the inability to teach practically, were underpinned by the teacher's lack of understanding of science concepts and processes.

Teachers should know Science very well in order to teach it effectively. If the teacher lacks Science content or is not confident in teaching content, learning is negatively affected. Selvaratnam (2011) found that a great number of physical science teachers in KwaZulu Natal high schools had problems in solving basic physical science problems. This is a problem in science teaching because teachers are important.

Muwanga-Zake (1998) blames teacher training for science teachers who just rely on textbook notes and practical instructions in their teaching. Muwanga-Zake (1998) also states that some science teachers cannot use science equipment available in schools and cites an example of a teacher who could not assemble a balance. This shows the quality of teachers teaching science in schools. In some instances, teachers with no science background teach science in schools.

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In a study to examine the relationship between teacher quality and teaching effectiveness, Lin, Xie, Jeng and Huang (2010) found that the two were positively related and that teacher quality was a strong predictor of teaching effectiveness. Similarly, Wang and Fwu (2007) argue that there is no good education without good quality teachers. In science education, there is a need for competent and experienced science teachers to teach the subject. This will not only ensure content accuracy and use of appropriate teaching approaches, but also motivation to learners. In defining teacher quality, Lin et al (2010:168) say it:

> is defined as teachers engaging in education tasks, with certain characteristics, and being able and qualified to conduct teaching activities, arousing students' interest in learning, and enhancing students' learning achievement.

It is important in the context of the study's focus on science teaching to ascertain the nature and level of training science teachers have undergone as well as the usefulness of science teaching approaches they employ.

Research has shown a positive correlation between a teacher's academic qualifications and student achievement (Betts, Zau & Rice, 2003; Wayne & Younger, 2003). A teacher with higher academic and professional qualifications potentially has a greater influence on students' achievement owing to his or her sound content knowledge. Angrist and Lavy (2001) call for teachers to be trained in diverse specialisations in order to teach effectively. Not any teacher who can teach science. One should ideally have a degree in Science and an appropriate teaching qualification in order to be adequately prepared to teach Science at junior secondary school level.

Teacher quality in terms of level and nature of training, academic and professional qualifications as well as teaching experience impact their teaching. Berliner (2005:207) has this comprehensive understanding of good and successful teaching:

> By good teaching we mean that the content taught accords with disciplinary standards of adequacy and completeness and the methods employed are age appropriate, morally defensible, and undertaken with the intention of enhancing the learner's competence with respect to content. By "successful teaching" we mean that the learner actually acquires some reasonable and acceptable level of proficiency from what the teacher is engaged in teaching.

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From the above observation, the teacher's content knowledge is important to ensure effective teaching and learning and use of appropriate teaching and learning approaches is vital. In a study that compared teaching abilities of trained and untrained teachers on the same type of students in teaching Mathematics, Bressoux (1996) found that training of teachers improved learners' scores in Mathematics significantly. This further shows the significance of having properly trained and qualified teachers to teach specific subjects in schools.

2.5.1 Teachers' Subject Matter Knowledge (SMK)

Kleickmann et al (2013) state that Pedagogical Content Knowledge (PCK) and Content Knowledge (CK) are key components of teacher competence that affect students' progress. Content Knowledge is referred to by Ball, Thames and Phelps (2008) as knowledge of the subject matter. In the teaching of science, this means how knowledgeable the teacher is in Science as a subject. In order for one to teach effectively, knowledge of the subject should be detailed. In showing the importance of the teacher's deep understanding of the subject matter he or she teaches, Shulman (1992:9), states that “the teacher need not only understand that something is so, the teacher must further understand why it is so.” The teacher, therefore, should be an expert in the subject that he or she teaches. Schmidt et al., (2007) says that in order for teachers to develop a thorough knowledge of subject content, there is need to include in the teacher training curriculum rigorous and demanding subject matter courses.

Subject matter knowledge (SMK), also known as content knowledge (Shulman, 1992) encompasses the theories, principles and concepts of a particular discipline that is to be learned and taught. Shulman states that SMK is the amount and organization of knowledge in the mind of teacher. Akerson and Volrich (2006) observe that SMK requires independent knowledge and understanding of facts and constructs and the connections between facts and constructs of a discipline. They further state that teachers must be aware that some ideas are more fundamental than others, some justify others and some encompass others. These enable teachers to know whether questions and hypothesis will lead to better understanding or confusion.

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Teachers' lack or limited knowledge of the subject negatively impact on their classroom practice (Luera, Moyer & Everett, 2005). Compared to teachers with strong science SMK, teachers with weak SMK teach less science and choose paper and pencil exercise more often than inquiry-based science didactics (Kim & Tan, 2011). Akerson (2005) argues that teachers can develop their subject matter knowledge through reading and talking with other teachers. Avraamidou and Zembal-Saul and Davis (2006) state that SMK is necessary but not sufficient for effective teaching. Teachers also need knowledge that blends subjects matter and pedagogical knowledge.

2.5.2Teachers' Pedagogical Content Knowledge (PCK)

According to Shulman (1992) there are key elements in PCK namely; knowledge of representation of matter as well as understanding of specific learning difficulties and pupils conceptions. Park and Olivier (2008) acknowledge the importance of teachers' understanding and practical implementation of the curriculum informed by contextual, cultural and social limitations in the learning environment. Davis (2006) states that while pre-service teachers do have some knowledge of instructional strategies in an early stage of their studies, the other aspects of science PCK develop through extensive experience as a teacher.

Kriek and Grayson (2009) indicate that there are serious concerns about the state of science education in South Africa and further observes that concerns are around teachers' lack of content knowledge in science, challenges in use of appropriate teaching methods as well as unprofessional conduct (Dudu, 2013). Teachers may be asked to teach Science when it is not their area of specialisation, due to staff shortage in schools. Such teachers may be trained as generalist teacher but not as Science specialists (Fensham, 2008). Villanueva and Webb (2008) observe that some teachers may be trained in Science teaching but still lack teaching approaches that make emphasis on inquiry. Learners should be involved in investigations as inquiry into scientific issues. Dudu (2014: 241) states that:

> School science inquiry is seen as similar to the inquiry done by professional scientists as students also investigate the world, propose ideas and justify explanations based on collected evidence.

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Science teachers, therefore, should have a thorough understanding of what Science is and how it can be appropriately taught in order to come up with learner centred inquiry-based teaching and learning approaches. In this view, teachers will not adopt traditional, rote-learning and theoretical approaches to science teaching and learning. Teachers have to be trained and experienced in conducting investigations in order to effectively utilise inquiry based activities (Webb & Glover, 2004).

Research suggests that educators who lack experience, confidence and general pedagogic content knowledge will often resort to methods of expository teaching, rote learning and avoiding classroom situations where something might go wrong (Makgato & Mji, 2006). The quality of South Africa's education places it last out of 148 countries according to the world economic forum. According to the Global Information Technology (2014) under the skills sub-category, the quality of South Africa's Maths and Science education comes in last place behind the likes of Haiti, Lesotho, Chad, Nigeria, and Kenya. The quality of South Africans' education puts it in 146th position. Lastly the researcher of the opinion that teacher development is needed to help the teachers to be specialists in science hence it was important to establish teacher preparedness in Science teaching in terms of teachers' Science qualifications, science teaching experience and professional development opportunities offered in Science teaching.

2.6 PROFESSIONAL DEVELOPMENT AND SUPPORT FOR TEACHERS

Professional development refers to the development of a person in his or her professional role (National Staff Development Council (NSDC), 2007). It is a recognition that professionals need to continuously update their knowledge and skills to improve the way they do their work. Professional workshops and other related formally meetings are part of the professional development experience (Ganzer, 2000). The researcher is of the view that purpose of teacher development is to improve teachers' strategies in the classroom. When they work as groups, teachers learn from each other and benefit as their skills are sharpened and their confidence boosted.

As the NSDC (2007) notes, professional development enables an individual to become a specialist in the subject. Burns (2011) identifies models of teacher-centred professional development such as observation/assessment, open classroom, lesson study, study group and looking at student work. Burns (2011) states that in the observation model the professional development provides, specialist or experienced teacher observes teachers in their classrooms and assesses their practices and provides feedback. The aim is to support the teachers' growth.

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In the open classroom model, the purpose is to see other teachers in action (Burns, 2011). Teachers create lessons and invite colleagues to observe the lesson and provide feedback in a post observation session. Both parties' benefit one from observing others and the other from feedback received. In science teaching, teachers need platforms where they meet and share ideas on best practices. Some may demonstrate good teaching practices for the benefit of others.

Lesson study model is a well-studied and highly successful form of professional development. In this model teachers plan, develop and improve lesson plans (Stigler & Hiebert, 1999). This model is based on collaboration as teachers in the same area of specialisation may plan lessons together or even set common assessment tasks together. This is done to improve practice for the benefit of the learners. Stigler and

Hiebert (1999) acknowledge that this model enhances teachers' designs and instructional skill.

In the study group model, teachers benefit from formal discussions and interactions with peers around critical issues. In this model, teachers work as groups or small teams to study a particular issue, with the goal of solving a problem. They may use classroom materials such as work created by their students. This model is, again, based on collaboration as teachers meet in small groups to solve particular challenges encountered in their teaching. Looking at student work is a model of teacher collaborative self-study and formative assessment that focuses on examining students' work and assessing the way the teacher designed the particular activity being reviewed (Stigler & Hiebert, 1999). In this model, teachers collaboratively examine students' work linking it back to how student learn and how the lessons were designed. It was one aspect of this study to establish teacher preparedness in science teaching by ascertaining the existence and nature of professional development programmes [illegible] specifically for science teachers.

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2.7 LEARNERS' INTEREST AND SCIENCE LEARNING

It is important for teachers to make lessons interesting to develop positive attitudes towards learning by the learners. According to Hudson (2007) teacher enthusiasm for a subject can play a role in students' own attitudes towards the subject and their retention of its content. Cimer (2007) states that practical work, field trips and writing activities can be employed to draw learners' interests .An international comparative study, Relevance of Science Education (ROSE), conducted by the University of Oslo, was developed to enable informed discussions about how to enhance school students' interest in science and technology and how to improve school science curricula and concentrated on school students' views. ROSE (2004) states that only a small number of students from industrialised societies have aspirations to become scientists or technologists with girls showing particularly low interest.

This highlights a sharp contrast with learners, of both genders, from developing countries who indicate that they value careers in science and technology highly. As practical work is more involved in terms of preparation and delivery, teachers may avoid full class practicals in favour of brief demonstrations. Subject content may be delivered through practical investigation and problem solving that is motivating and enthusing for learners (ROSE, 2004). In line with (ROSE) Project (2004), science teachers must be able to develop learners who have both theoretical knowledge and practical skills in NS. The study intended to establish participants' views on the teaching and learning methods employed by the teachers in NS.

ROSE (2004) further notes that learners also recognised that having access to practising scientists and engineers would promote their interest and enthusiasm towards science and engineering. Learners indicated that visiting professionals can provide valuable information regarding their careers. Work done through the ROSE project and by Osborne and Collins (2000) also show that learners tended to enjoy classroom science and are positive about their teachers. The study sought to understand how learners were involved in the learning of science in ways that not only promoted their understanding but interest of the subject as well.

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2.7.1 Practical work

Practical work can provide a good opportunity for learners to apply their newly acquired knowledge or skills and gain first-hand experience of phenomena covered in theory (Amos & Boohan, 2002; Millar, 2002). When learners engage in practical work, they can test, rethink and reconstruct their ideas and thoughts. Research has proven that practical work improves learners' learning and understanding (Dawe, 2003).

2.7.2 Field trips

Field trips can provide learners with meaningful contexts where they can connect their knowledge with the natural world and see examples and practical applications of scientific concepts or processes (Griffiths & Moon, 2000; Tytler, 2002). However, field work is not always possible due to a limited budget and increasingly busy curriculum. Teachers can, however, bring the natural world into the classroom by providing live plants, animals, pictures, models and the display of student work (Griffiths & Moon, 2000).

2.7.3 Writing activities

Henderson and Wellington (1998) suggest that teachers should explore different ways of getting learners to present written records of their investigations and observations and to give them opportunity of showing that they understand a scientific topic or concept. The forms of writing may include journals, questions and cartoons.

2.7.4 Active learning

Active learning, which also takes form of discovery learning, emphasises the intrinsic and self-sponsored curiosity of learners are actively involved in content determination (Leonard, 2002). In his classic article, Bruner (1961) states that learners are more likely to remember concepts if they discover them on their own, apply them to their own knowledge base and context, and structure them to fit into their own background and life experiences. In active learning, the instructor serves as a catalyst directing projects that centre around solving a problem. Students that are actively involved in the analysis, synthesis, and evaluation of content gain a better understanding of the information than they would otherwise have through passive, instructor-centric learning.

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Bruner (1961) also observes that in active learning, the mode of instruction must allow the students to create authentic, hands-on learning experiences in order to learn new information. In active learning, students become participants in their own education, increasing the likelihood of retention.

2.7.5 Collaborative learning

Collaborative learning is defined as a method of learning in which students are placed in teams of two or more people to explore a significant question or create a meaningful project through capitalizing on each other's resources and skills (Chiu, 2000). The benefits of collaborative learning include the development of interpersonal skills (Jun & Pow, 2011), active involvement in the teaching and learning process (La-fifi & Touil, 2010), enhancement of critical thinking (Cheong, Bruno, & Cheong, 2012) learning conflict resolution, and taking ownership of the project/results (Johnson & Johnson, 1999). The use of questions is also very important in enhancing the learner's interest in the classroom.

Learners find the questions and, project learning which is relevant to their lives and their world or culture, interesting. The questions become anchors for tying together all the new information that learners are learning, which results in the information making more sense. For example, in the unit "What is the quality of Air in My Community?", designed for seventh graders, the learners develop an understanding of the factors that affect air quality with a focus on the particular nature of matter, chemical and physical properties (Singer et al., 2000). Cooperative learning can include a range of elements; one facet being the assignment of roles to each learner within the group (Johnson & Johnson, 1994). Johnson and Johnson (1994) further state that if roles are not properly assigned and defined in group tasks, not all learners will benefit from group work. Learners generally enjoy taking on roles and would work to achieve them, only if they are properly assigned to them. The teacher's role in cooperative learning is essentially that of a planner of learning tasks and facilitator of active learning. The teacher is supposed to monitor, observe and assist in problem solving during group work, ask open-ended questions, praise and encourage learners, provide extension ideas and activities, facilitate learner roles, responsibility and self-reflection, and promote student learning of meta-cognitive and social skills (Johnson & Johnson, 1994).

2.8 CAPS AND INDIGENOUS KNOWLEDGE SYSTEMS IN NS

The National Curriculum Statement was based on the notion of 'science for all', and in keeping with the transforming socio-political environment, adopted a more humanistic approach. This was enshrined in the school curriculum policy for Natural Sciences as Learning Outcome 3, which promotes the teaching of indigenous knowledge systems (IKS) in the science classroom (Naidoo, 2010:23). The current policy document, the Curriculum and Assessment Policy Statement (CAPS) for Natural Sciences, aims at ensuring that 'learners acquire and apply knowledge and skills in ways that are meaningful to their own lives. In this regard, the curriculum promotes the idea of grounding knowledge in local contexts' (Department of Basic Education (DBE), 2011c:3). The CAPS document underscores the following

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principles: valuing indigenous knowledge systems, acknowledging the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution' (DBE 2011c:3). The principles and aims of the curriculum are formulated to be achieved through specific aims, which outline those cognitive competencies to be developed by learners. These policy changes signal a route towards curriculum reform, a way to reconceptualise the curriculum to make it more sensitive and responsive to the 'multiplicity, difference and identity affirmation that conditions the postcolonial period' (Kanu, 2006:7).

Many practising South African teachers, however, are not in favour of the change in curriculum, because this new curriculum expects more from teachers (Hewson, Javu & Holtman, 2009). There is need for teacher support in curriculum implementation. Ogunniyi (2007) and Govender (2009) confirm this by asserting that many science teachers do not implement curricula which include IKS, because they lack the relevant knowledge and skills. Ogunniyi (2004) argues that the practices which are embedded in the cultural values of [illegible] people have begun to wear away, because of the influence of western science in the education system of schools.

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Ogunniyi (2004; 2007) further points out that because the re-emergence of IKS is still in its elementary stage, the insight into, and experience of IKS, is limited, which poses challenges for its inclusion in curricula. This challenge is compounded by linguistic barriers, where the same word can be interpreted differently by different cultural groups. A critical analysis of the NCS by Botha (2010) has resulted in the authors' conclusion that western science dominates the NCS and that the worldviews of indigenous people of South Africa in education continue to be relegated to the margins. Botha (2010) calls for the South African education system to represent the demographics of the country, and to be more inclusive of, and responsive to, African traditions and culture. This can be achieved by adopting a more collaborative approach to science teaching and learning, where indigenous knowledge and western science are combined.

Amongst the principles and aims of the NCS is the requirement that science take cognisance of the learner's social context, in order to be meaningful (Department of Education, 2011b). This has implications for the type of training which teachers receive at higher education institutions. Currently, higher education institutions are considering the potential value of IKS and are re-designing courses/modules to recognise IKS. Naidoo (2010:14) observes the establishment of IKS faculties in certain South African universities; as signalling a heightened awareness of the importance of focusing on IKS in tertiary education. Some universities have introduced a Bachelor of IKS degree, which confirms the endorsement of other ways of knowing by these institutions.

According to Govender (2009), pre-service teachers are aware that indigenous practices are not simply ways of doing, but that they involve intellectual engagement and this motivates these teachers to find ways to incorporate IKS in the science classroom. A theoretical understanding of how pre-service teachers learn to teach IKS is vital in order to advance African scholarship. The study intends to address the use and importance of IKS in schools, as they play a role in the teaching and learning of NS. Hence the purpose of the study is to establish how the NS is implemented in junior secondary schools, the aim is to promote these IKS in the curriculum.

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2.9 CHALLENGES IN SCIENCE TEACHING AND LEARNING

There are numerous challenges encountered in the teaching and learning of science subjects in schools. Kola (2013) states that science teachers are key factor to be considered when talking about the development of science education in any nation. There are shortages of qualified science teachers in Nigerian schools. The science teachers are not professionally qualified. They may have the knowledge of the subject but lack the method. Kola (2013) notes that problem of the existence of unqualified science teachers in schools. The present study sought to find out how prepared teachers were in the teaching of NS in terms of their training and specialisation in science teaching.

Another challenge, there is a lot that has been said about STEM skills (Science, Technology, Engineering and Maths.) According to Thornburg (2009), much of the work in Science, Technology, Engineering and Maths (STEM) treats them as separate subjects that are independent from each other, not as topics. Students should be provided with opportunities for cross-disciplinary work before graduating from high school. Thornburg (2009) further highlight that while maths, science and (some) technology are taught as separate subjects in school, the power of treating the STEM subjects in an integrated fashion strengthens the understanding of each of them. This is essential because technology and engineering are more likely to be found in career academies than solely in academic high schools (Thornburg, 2009). When students see (and understand) the interconnectedness of these four fields, they may find themselves more motivated to explore the individual subjects in detail. Hence the study sought to suggest how the implementation of NS curriculum be enhanced to promote scientific literacy in learners.

2.9.1 Availability of Specialist Science Teachers

It is important to have specialist science teachers to ensure effective science teaching in schools. Science Community Representing Education SCORE (2011) uses 'specialism' to refer to the subject knowledge gained by a teacher through their degree qualifications and experience and recommends the use of teachers who are subject specialists. Dudu (2013) and M[illegible] and Mji (2006) laments the problem of lack of qualified science teachers in South African schools. Hence the study sought to establish the teachers' qualifications, training and experience in the teacher preparedness in teaching and learning of NS. It was the purpose of this study to establish the extent to which teachers teaching NS in selected rural junior secondary schools were specialised in the subject areas. The importance of science requires that appropriately qualified, specialised and experienced teachers teach the subject.

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A number of recent studies have drawn attention to weak teacher content knowledge (Stols, Olivier & Grayson, 2007; Taylor & Moyana, 2005). Although the evidence is accumulating, it is less clear what can be done about teacher content knowledge. It is true that there is something that needs to be done about content knowledge of teachers because to master the subject one must be well versed in terms of the content. It was important for this study to address the factors affecting the implementation of the NS curriculum by considering at the availability and preparedness of teachers in science teaching. Availability of teachers is dependent on favourable working conditions and working environments (Gustafsson & Patel, 2008). The study focused on rural schools that are generally deprived in terms of material and human resources.

2.9.2 Resources in Science Teaching and Learning

Idiaghe (2004) notes that availability of resources and academic productivity in learners are closely related. 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. It was the purpose of the present study to establish how teaching and learning of Science was conducted in generally deprived rural schools. Science, as a subject, requires adequate resources and facilities to ensure effective teaching and learning.

Appropriate resources in science teaching are pivotal as, according to Mudulia (2012:531) "all scientific truths must be discovered through observation and experiment, not telling…." Laboratories, where experiments are conducted, should be available in schools to ensure effective teaching and learning of science. 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, laboratory chemicals and equipment should be readily available.

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The resources needed for teaching Natural Science in South African junior secondary schools are listed against each topic in order 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, 2011c). The policy document states that every learner must have his/her own text book. Teachers should ensure that a system is in a place for recovering textbooks at the end of the year. Schools must provide secure storage space for textbooks and other equipment.

Every learner should have access to sufficient workspace and equipment to carry out investigations. For safety and educational reasons it is recommended that no more than three learners share space and equipment. Teachers should ensure that learners are familiar with rules regarding the safety of equipment. Schools must make every effort to ensure that the essential equipment is provided. Tools, apparatus, materials and consumables must be acquired through a planned budgeting process. The Department of Basic Education (2011c) 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. In instances where equipment is limited, teachers should improvise. The same knowledge and skills can be developed using improvised equipment. It is important for teachers to improvise where possible to ensure that meaningful teaching and learning takes place.

After determining learners' existing ideas and conceptions, teachers need to introduce scientific concepts to help them construct new knowledge. For this purpose, teachers can use short lectures or presentations, watch videos or film, read passages from textbooks or reference books (Trowbridge, Bybee & Powell, 2000; Glenn, 2001). Focusing learners' attention on the material to be learned is an important factor in effective learning (Joyce, Calhoun & Hopkins, 2000). Teaching materials should match individual learning styles, i.e. visual, auditory and kinaesthetic (Joyce, Calhoun & Hopkins, 2000).

According to Amos and Boohan (2002) multimedia can help teachers bring the real world to learners through the use of sound and video, 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. McSharry and Jones (2000) see role-play in science teaching and learning as supporting "active", experiential or learner-centred learning. This is in line with Vygotsky's social constructivist theory. Recourses play a significant role in the teaching and learning of science.

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The importance of laboratory, apparatus, electricity in teaching and learning of science cannot be overemphasised. When learners do hands on activities in the laboratories they understand more. Some researchers twenty years back reported the importance of laboratory in science teaching and the review was made which identified several methodological short comings in the science education research which will inhibit the ability to present a clear picture regarding the utility of the science laboratory in promoting understanding for learners. 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.

Lunetta (1998) emphasises the importance of rethinking the role and practice of laboratory work in science teaching. The National Science Education Standards (National Research Council (NRC), 1996) also indicates the importance of engaging learners in describing and in using observational evidence and current scientific knowledge to construct and evaluate alternative explanations based on evidence and logical argument.

Engaging in scientific argumentation assists students in constructing meaningful science concepts and in understanding how scientists develop knowledge of the natural world. Driver, Newton and Osborne (2000) note that weighing and interpreting evidence, thinking about alternatives, and assessing the viability of scientific claims are essential elements of scientific argumentation and of school science. Orji (2006) found strong relationship between teachers' know-how and learners' achievement. He further found that library materials and science laboratory equipment are positively related to the performance of learners. Science instruction/teaching is more effective when laboratory materials are available and when these are well used.

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The use of Information and Communication Technology (ICT) includes computers, projectors, very important especially when the teacher is introducing new concepts and experiments that need visuals. However, not many teachers are conversant with using ICT which may present challenges.

Dawe (2003) sees new technologies as providing opportunities for effective communication between teachers and learners in ways that have not been possible before. However, this potential may not easily be realised, as according to Dawe (2003) teachers may find themselves operating under very difficult conditions of lack. According to Bransford, Brown and Cooking (2000), several studies have reviewed literature on ICT and learning and concluded that it has great potential to enhance learner achievement and teacher learning. Wong et al (2006) shares similar views with Bransford et al (2000) by pointing out that technology can play a part in supporting face to face teaching and learning in the classroom. When using DVDs in the classroom, for instance, showing learners the connection of electric circuits, then learners will watch and do hands on immediately and they grasp easily learners understand better and can practically demonstrate the skills without the help from the teacher. Grabe and Grabe (2007) claim that ICT can be used to present information to students and help them complete learning tasks. Pickersgill (2003) explored effective ways of utilising the internet when teaching science. He found that the use of internet allows teachers to help learners to become experts in searching for information rather than receiving facts.

2.9.3 Learners Background and Learning of Science

International benchmark tests indicate that South African learners are performing poorly in science. For example of the 38 and 50 countries that participated in the trends in mathematics and science study (TIMSS) in 2001 and 2003, respectively, some of which are developing countries, South African learners came last in mathematics and science (Howie, 2001; 2003).

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Reddy (2004) who coordinates the study in South Africa, explained that there are multiple complex that contribute to learners' poor performance. These include poverty, resources, learning cultures, infra-structure of school and low teacher qualification. The poor infrastructure and limited resources can have a negative effect on science teaching and learning. That would inhibit the learners' interest in science.

Connected to learners' background and the teaching and learning of science is the issue of language. Science is taught in English and English is a foreign language to all the learners in rural schools. Research has shown that use of foreign language in teaching and learning results in numerous problems for learners. Tan and Tan (2008) state that learning in a second language is deemed problematic when learners encounter difficulty in interpreting the meaning of Mathematics and Science discourse. Teaching science in a foreign language results in learners' problems of understanding concepts taught. Similarly, Ong and May (2004) observes that the problem is worsened if the science teachers are not proficient in English.

Teaching Science in English to second language English speaking learners negatively affects the learners' performance (Ferreira, 2011). In a related study, Ferreira (2011) found that learners did not only experience challenges with English as a language but also with scientific language. Schaffer (2007) notes that science lessons taught in English are language lessons as they involve learning both science and the language. Rural learners learning science do not only grapple with science content but also with a language that is foreign to them. Mokiwa and Msila (2013) further note that language has a strong effect on educational quality and rural and historically black schools in South Africa have the problem of the use of English as medium of instruction, which impacts on quality of education.

Underlining the significance of language in science teaching and learning, Taylor and Prinsloo (2005) also state that learners' lack of proficiency in the medium of instruction is the largest single factor that affects learner performance at school. If the language used in teaching and learning of science is the language learners are not proficient in, then it becomes a hindrance in their understanding of science concepts and processes.

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Over the last 15 years, poor performance in South African Education, particularly in science and mathematics has been documented in academic research (Christie, Butler & Potterton, 2007). The findings of the third International Mathematics and Science study in 1998 and the Trends in Mathematics and Science study in 2003 revealed that, of the 50 participating countries, South Africa grade 8 learners were the lowest performers in almost all test items in Mathematics and Science, well below international benchmarks. In the TIMMS, grade 7/8 and grade 12 learners representing South Africa were considered scientifically illiterate. Female learners from all population groups performed particularly poorly (Howie, 2001). The majority of South African learners could not communicate their scientific conclusions, had difficulty articulating their answers, and even experienced trouble comprehending most of the questions. Howie (2001:2) argues that these problems can be attributed to English as the language of learning and teaching.

It has also been noted that in the early years of schooling pupils' listening, speaking, reading and writing skills were poorly developed in both their first language and in English (Alidou, Boly, Brock-Utne, Diallo, Heugh, & Wolff, 2006). Researchers like

Taylor and Vinjevod (1999) posit that the sound performance in school depends on basic literacy skills on which the majority of black South African children from disadvantage homes are severely handicapped. The authors observe that learners' level of language competence in schools is so poor that they are unable to read the learning materials provided for them, and the tasks and exercises they are given are often conceptually too difficult and beyond their competence. Many studies have found that primary school learners usually have positive emotions and attitudes towards science (Brigido et al, 2010). These however decrease with age, especially during secondary schools (Murphy & Beggs, 2013). However, Marba and Marquez (2010) mention that secondary school learners have positive attitudes and emotions towards nature sciences but negative ones towards physics and chemistry. Scantlebury (2012) notes the preferences of boys for physics and chemistry and girls for life sciences. One reason for this could be the gender stereotypes associated with professional roles (Gutierrez & Luengo, 2003). Such gender stereotypes are reinforced by the treatment given in textbooks, in which the history of science has an overwhelming presence of men, and the contribution of women is ignored (Togrol, 2013).

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The use of language in science education is very important as it helps and support learners learning in science. Learners from disadvantaged background they encounter challenges as they are used in learning with their mother tongue. Most educators attest to the fact that learners have language deficit, which holds them back not only in their learning, but also in simple social exchanges with one another (Reddy, 2004). Brock-Utne (2000) argues that using a second language as LoIT is a great constraint which hinders acquisition and expansion of science education. It has to be stated that it is often erroneously believed that science is relatively independent of language. Lewin (2000) asserts that many problems of science learning may be associated with lack of language proficiency because more often than not for disadvantaged leaner, "science is taught through a medium of instruction which is not a mother tongue". Mutasa (2002:7) asserts that "if pupils do not understand the language used in teaching science, it means they do not and cannot receive education in the discipline". Bell (2001:140) asserts that teaching and learning are vastly facilitated through the use of language. Not only is language used by educators to communicate information to learners, but is also necessary for the complete formulation of concepts and principles. Mclean (2000:125) also notes that many of the learners' learning problems in science originate from an inadequate knowledge of the basic vocabulary of the language of learning and teaching.

In contrast with a basic skills approach to learning, social constructivists claim that meaning is constituted through a variety of social practices, especially language, which is a primary mediator (Reagan, 2003). The core of constructivism is the belief that learning is an active process in which learners construct new ideas and knowledge based upon their current and past experiences. The learner selects and transforms information, constructs hypotheses, and makes decisions relying on a cognitive structure to do so (Brunner, 1986). According to constructivist theory, which is based heavily on the work of Vygotsky (1985) and Piaget (1972), genuine learning is deeply subjective and intensively active. Learning occurs when learners actively assimilate new information and experiences and constructs their own meaning. Osborne and Collins (2000) describe a constructivist theory as learners' ability to comprehend what they are taught verbally or what they read or what they find out by watching a demonstration or experiment.

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2.10 WAYS TO IMPROVE TEACHING AND LEARNING OF SCIENCE IN SCHOOLS

Staver (2007) observes that there are several ways of improving teaching and learning of N.S. Teachers should teach NS with strategies and techniques that help learners become active thinkers where a newly constructed idea fits easily into the structure of existing understanding. Allowing learners to be active and critical thinkers helps in the construction of new knowledge as well as revision of existing knowledge into a new, more coherent framework. In still other instances, new and old ideas conflict but are retained and used separately. Learning is also a social and cultural process. Teachers should employ teaching strategies that help learners recognize conflicts and inconsistencies in their thinking, as these experiences promote the construction of new and more coherent knowledge.

Staver (2007) continued by noting that science content should also be linked to learners' interest and personal lives, with societal issues and with other school subjects. Content that is linked to students' experiences becomes easy to understand and motivates learners to explore more in science. In order to capture learners' attention and activate their motivation to learn, teachers must consider the relevance of each topic. Learning is made more meaningful, if content is made relevant to learners' lives. Learners will be able to relate to scientific concepts aligned to their interests, personal lives, societal issues, cultural backgrounds, and other school subjects. Cognitive learning theory emphasizes the importance of learning something new by relating it to things that are already meaningful and familiar. Science teachers must remember that their own intrinsic motivation to learn science is likely not shared by many of their learners, whose motivation is more likely activated instrumentally, by connecting science to things that are already familiar and important to them.

Teachers should also set high expectations for learning for all learners. Teachers' expectations of how much and how well their learners will learn directly influence that learning. Teachers should set high learning expectations for all learners and encourage them to set high expectations for their own learning. Teachers express their expectations for, and beliefs about, their learners through both their nonverbal and verbal behaviours. Learners who are believed to be high-ability learners receive more positive nonverbal feedback from teachers such as smiling and eye contact. In cultures where learners' level of work and effort is considered directly related to their learning, high expectations for a student leads to higher achievement through more work and effort by learners of all abilities.

When designing and teaching science lessons, consider the complex interaction between learners' biological maturation, prior knowledge and experience and reasoning abilities so that the lesson challenges, but does not overwhelm learners' cognitive capabilities. Learning relies on a complex synthesis of biological maturation, prior knowledge and experience, reasoning ability, and instruction. Students' learning capabilities at any age depend heavily on their prior knowledge and experiences, which can help or hinder them from learning something new. This extensive range of knowledge and experience stems from learners' socio economic status, gender, ethnicity, culture, native language, and other factors. Different

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learners require different kinds of explicit instructional support and guidance to understand and do scientific inquiry and to understand the body of scientific knowledge. Asking questions during instruction is an effective strategy for assessing students' difficulties.

2.10.1 Parental support

Children of highly educated parents benefit more from education as their parents are able to assist more in their learning. Such children can make more progress than those who are not fully supported by their parents due to parental poor educational backgrounds (Driessen, et al, 2002). Mahlobo (2003) and Leithwood (2010) observe that parental involvement can also be in the form of academic guidance and provision of resources on school related tasks. Parents in this regard can meaningfully complement school efforts.

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According to Henderson and Berla (1994) the extent to which a family is able to create a home environment that encourages learning is the most accurate predictor of a student's achievement in school. This means that home environment should be very supportive to learning. Henderson and Berla (1994) argue that parental involvement in student learning has immense benefits to children. Students who are supported at home tend to achieve more, regardless of ethnic or racial background, socioeconomic status, or parents' education level. Children generally achieve better grades, have regular attendance, and complete their homework if parental support is strong. Supported children develop self-esteem, are more self-disciplined, show higher aspirations and motivation towards school, and develop positive attitude about school. Henderson and Berla (1994) argue that parental involvement also benefits parent, they become more confident in their parenting and decision-making skills. As parents gain more knowledge of child development, there is more use of affection and positive reinforcement and less punishment on their children they also get to have a better understanding of the teacher's job and school curriculum.

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Educators benefit too when parents are involved in the learning of their children. Henderson and Berla (1994) note that when schools have a high percentage of involved parents in and out of schools, teachers and principals are more likely to experience higher morale. Teachers and principals often earn greater respect for their profession from the parents. Consistent parental involvement leads to improved communication and relations between parents, teachers, and administrators. The school also benefits when parents play a role in the education of their children. According to Henderson and Berla (1994), schools that actively involve parents and the community tend to establish better reputations in the community. Schools also experience better community support. School programs that encourage and involve parents usually do well. The study sought, in part, to establish participants' views on what could be done to enhance the teaching and learning of NS in the promotion of scientific literacy in learners.

2.10.2 Linking content to what learners already know

It is important for teachers to present content in ways that involve learners in the learning process. Teachers can use specially structured materials to teach difficult information / skills. It is also important to assess learners' mastery of the content and attainment of learning outcomes as well as provide them with helpful feedback and further institutions, as needed to promote mastery. The concept is called anchoring routine according to Chin (2001). It is a routine with the package of instructional methods that teachers can use to help students connect new information that is already familiar to them. The power is that it capitalizes on the fact that all students regardless of their academic history have a rich set of background experiences. It helps learners make connections between known and unknown information. The researcher is of the view that linking content to what the learners already know is practicing constructivism, as the researcher furnished it in the theoretical work. Linking also helps to make the learners understand easily and connect to their daily lives.

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The Institute for Academic Access (IAA) (2001) is a collaborative partnership between faculty and staff at the university of Kansas and University of Oregon. The primary goal is to determine ways to improve educational outcomes and designing instructional methods that take into account the learners' unique characteristics and the complex dynamics that are unique to high school curricular and schools. IAA researchers' works collaborate with teachers in order to link the content to what the learners already know. They organize and transform the content into forms that are learner friendly. That means they want the content to be very easy to understand and remember. They consider what processes learners must use to learn the content and how to use the processes.

2.10.3 Making learning of science fun

Learning of science concepts should be made enjoyable. The Life Science Learning Centre (LSLC) (2002), for example, makes learning of science fun by making use of two teaching laboratories that accommodate up to 48 learners per day and are fully equipped with state-of-the art science equipment and laboratory supplies. Many of the programs that are taught by the University's renowned scientists share the excitement for the work they are doing to advance human health. Their curricula were developed with extensive input from master teachers, and feature real-life, engaging minds-on and hands-on activities that make science relevant and fun. Making science learning fun is integral to the effective implementation of NS curriculum in order to make learners interested and excited and not perceive science as a difficult subject.

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LSLC field trip programs provide sixth through twelfth grade students with authentic, hands-on lab experiences and exciting science problems to solve. In addition to field trips, the LSLC, scientists also offer summer and school vacation science camps and lifelong learning programs in the community. Further to that, they partner with University of Rochester undergraduate and graduate students to offer Science Buddies, after-school science clubs for fifth graders, at more than a dozen elementary schools in the Greater Rochester Area. They also offer professional development workshops on a wide range of topics in the biological and life sciences to give teachers experience with cutting-edge science technologies. These hands-on workshops provide innovative instructional materials that align with New York State Math, Science and Technology (MST) standards, as well as National Science Education Standards.

2.10.4 Making learning of science meaningful in solving societal problems

Norris and Philips (2003) observe that the term scientific literacy has been used to include various components from the following: Knowledge of the substantive content of science and the ability to distinguish it from non-science, understanding science and its applications, Independence in learning science, ability to think scientifically, ability to use scientific knowledge in problem solving. For learners to be able to solve societal problems they must think scientifically and critically and have the support of teachers who are qualified and experienced enough to teach NS and have sound knowledge of its content. The study, therefore, sought in part, to establish the preparedness of teachers for the task.

Scientific literacy needs to be related to an appreciation of the nature of science, personal learning attributes like attitudes, and to the development of social values (Holbrook & Rannikmae, 2007). Relevance of learning plays a role and teaching materials, striving toward student enhancement of scientific literacy, need to consider a societal frame, introduction of conceptual science on a need to know basis, and to embrace the socio scientific situation that provides the relevance for responsible citizenship (Holbrook, 2008). A forum on scientific and technological literacy for all (UNESCO, 1993) suggested the French term as “la culture scientifique et technologique,” a translation that clearly reflects the cultural intention and points the way towards recognising that a person who is scientifically and technologically literate is one who can function within society as a whole, rather than simply as a scientist in the workplace.

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Kim and Tan (2011) note that using concepts of science and of technology, adding ethical values, in solving everyday problems and making responsible decisions in everyday life, including work and leisure. Locating, collecting, analysing, and evaluating sources of scientific and technological information and using these sources in solving problems, making decisions and taking actions. Applying scepticism, careful methods, logical reasoning, and creativity in investigating the observable universe. To solve problems, critical thinking is needed and collecting ideas, analysing them and evaluating if they are going to serve the intended purpose. Displaying curiosity about the natural and human-made world, and recognizing that science and technology are human endeavours. Recognizing the strengths and limitations of science and technology for advancing human welfare. In solving the society problems, displaying curiosity before solving the problem is good and also recognizes the strengths and limitations. This study sought to know the extent to which teaching methods employed in the teaching and learning of NS, addressed societal problems.

2.10.5 Ensuring adequacy of resources in schools

The post-apartheid state inherited an education system was racially segregated and highly unequal in terms of intra-racial budgetary and resource allocations, based on a foundation of 'Christian National Education". This was characterized by gross inequality in the financing of education, with the African population receiving the smallest budget (Veriava, Roux & Wilson, 2010). Noting that, the results of these historically white schools have the advantage of decades of infrastructural investment and access to well-trained and qualified teachers compared to black education characterised by high teacher-pupil ratios, unqualified and under-qualified teachers, lack of books, libraries and laboratories, and a curriculum that perpetuated the myth of white superiority and black inferiority.

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Redressing this apartheid legacy requires a strongly pro-poor, redistributive funding policy for schools that helps upgrade the quality of infrastructure and teaching at historically disadvantaged schools. While there have been improvements to schooling infrastructure, historical backlogs remain, and progress in upgrading under-resourced schools remains slow16 years since the advent of constitutional democracy.

In 2002, of the 27 148 public schools, 2 280 (8,4%) had buildings in a state of disrepair, 10 723 (39%) had a shortage of classrooms; 13 204 (49%) had inadequate textbooks, 8 142 195 learners resided beyond a 5km radius from the school, 10 859 (40%) of schools were without electricity; 9 638 (36%) were without telephones; 2 496 (9%) were without adequate toilets, 19 085 (70%) lacked access to computer facilities; 21 773 (80%) lacked access to library facilities and 17 762 (65%) lacked access to recreational and sporting facilities (Veriava, Roux & Wilson, 2010). Shortage of requisite resources inhibits learners' interest in science. Veriava, Roux and Wilson (2010) report on the 2009 National Education Infrastructure Management Study (Department of Education 2007) backlogs in the infrastructural provisioning in schools. According to that study, out of the 24 460 public schools: 3600 (14,7%) have no electricity supply, while a further 800 (3,3%) had an unreliable electricity supply; 2444 (10%) have no water supply, while 2563 (10,1%) have an unreliable water supply; only 7847 (32%) have municipal flush toilets, while 970 (4%) still do not have any ablution facilities and 11 231 (46%) still use pit-latrine toilets. Only 8% have stocked and functioning libraries; only 10% have stocked computer centres and; only 5% have stocked laboratories. These challenges compromise curriculum implementation effectively that is why the study sought to address the challenges of resources in science teaching and learning.

Jita (2004) notes that developing countries face greater challenges in science education than economically developed countries due to lack of teaching materials including books, computing and communications technologies, community-based science centres, laboratory facilities and equipment, as well as shortage of skilled teachers.

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2.10.6 Availability of well-trained science specialists as teachers

SCORE (2011) member organisations believe that the presence of a specialist science teacher at primary and lower secondary level is likely to be crucial in nurturing students' imagination and embedding long-term interest in the sciences. There is some evidence that teachers with good subject knowledge have a positive influence on students' attainment in and attitude towards the sciences (and indeed other subjects), although this is unlikely to be the only influence on students' subject choice (SCORE, 2011).

SCORE (2011) further notes that, at present, there are no direct means of measuring subject knowledge. The best measure available is the highest qualification of the teacher. While there is some evidence to suggest teachers with subject specialist knowledge positively influence the teaching and learning of the subject. SCORE (2011) makes a clear distinction between subject specialism and teaching expertise. It is vital to have well trained science specialist who will enhance the teaching and learning of science in schools. Such teachers will motivate and stir interest in learning science. Hence the study sought to establish the preparedness of teachers in science teaching by looking at the availability, training, professional development and support of the teachers.

2.11 PREVIOUS STUDIES ON THE TEACHING AND LEARNING OF SCIENCE IN SCHOOLS

There are previous studies which talk a lot about teaching and learning of science for example science educators in South Africa are aware of some of the problems, such as long syllabi, useless objectives, illogical sequencing of topics in the syllabus, examinations that test for facts and a curriculum development process that does not recognise teacher inputs (Muwanga-Zake, 2001).

In many countries around the world, teachers are not well prepared to teach scientific subjects and indeed, may be more effective in driving learners away from scientific disciplines than attracting them, because of their lack of preparation (OECD, 2008). Commenting on shortages of engineers in South Africa, Mdakane (2007), a managing director of the National Society for Black Engineers, traced the problem of skills shortages back to secondary school education. Secondary schools fail to provide universities with learners who qualify to enter the profession, because of the poor matric pass rate in mathematics.

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Fricke, Horak, Meyer and van Lingen (2008) posit that international benchmark studies confirm that school mathematics and science in South Africa is weak and suffers from systemic problems. A question that is worth asking is: Is the curriculum of natural science implemented very well in junior secondary schools? Are the CAPS documents clear to the teachers who are implementing the curriculum?

2.12 TEACHING AND LEARNING IN RURAL SCHOOLS

Many South African rural schools may have a challenge in attracting well-qualified and trained teachers due to their disadvantaged nature (Webb, 2009). Gardiner (2008) notes that the South African Constitution, the South African Schools Act and various education policy documents say that all South African learners should have access to the same quality of learning and teaching, similar facilities and equal educational opportunities. However, this is not yet the case. Most schools, particularly in rural areas, are characterised by lack of classrooms, poor access to services such as water and electricity, no landline telephones, internet, and very few public or school libraries.

Gardiner (2008) highlights that many of these problems are linked to socio-economic factors such as poverty and unemployment. Such challenges have a direct influence on the quality of education that is available learners. The poorest and least-developed rural communities are those that were located in the former homelands, particularly in Eastern Cape, KwaZulu- Natal and Limpopo. The legacy of poverty and neglect in these places is far from being eliminated, partly because of the emphasis in South Africa on urban development.

2.13 THE SOUTH AFRICAN EDUCATION SYSTEM

Villanueva (2010) notes that the 1994 democratic elections put an end to apartheid in South Africa. However, colonial remnants are still pervasive throughout the nation (Human Sciences Research Council (HSRC), 2006). Statistics indicate that, in a country of over 49 million inhabitants, 24.5% of the population is unemployed (Statistics South Africa, 2009). Additionally, South Africa has one of the highest Gini coefficients (0.57) suggesting that the nation has one of the most unequal income distributions in the world (United Nations Development Programme [UNDP], 2007). The Gini coefficient suggests that approximately 45% of the South African population obtains only 25% of the country's income. Black South Africans are the most affected group and, as a consequence of apartheid rule, continue to be affected by inequalities in terms of employment, income and education (Reddy, Juan, Gastrow & Bantwini, 2009).

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Villanueva (2010) also says since 1999, the Department of Education has focused on the quality of teaching and learning, and inputs at the local level (DoE, 2006). The transformative efforts also reflect the nation's economic and human development strategy, which emphasises the centrality of science and mathematics and recognises that the development of mathematical, scientific and technological skills require intervention at school level (Reddy, 2006). However, despite government's reconstructive policies and efforts to improve science and mathematics education, black South African schools still face “crippling” backlogs of resources, infrastructure and qualified teachers, all of which are necessary conditions to improve participation and achievement in science and mathematics (Reddy, 2006).

The Eastern Cape Province is a large province with many rural districts. The province has historically been seriously impacted by discriminatory education delivery in the pre-democratic system in South Africa. In the current democratic system, the province continues to struggle to overcome the serious under-performance in most schools. The province was ranked 9th out of the nine provinces in both Mathematics and Physical Sciences performance in the 2012 NSC examination. The document further continues by saying:

> Schools have a serious shortage of qualified and competent educators - the resultant impact on the teaching of mathematics and science is sufficiently serious to foreground the need for a systematic programme to upgrade educators’ competence both in content and pedagogy to enable them to teach the curriculum efficiently. The province reports poor teacher development both in-service and pre-service.

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Teachers also raised concerns about the learners' competence of some curriculum advisors and the high ratio of curriculum advisors to teachers. This often results in teacher workshops being below standard. They also suggested that workshops be complemented by follow-up classroom support by curriculum advisors. Communication is a general problem throughout the system.

2.13.1 Science teaching and learning in the Curriculum Assessment and Policy Statement (CAPS)

In order to give a solid foundation to Natural Science, three specific aims in Natural Sciences and Technology module are emphasised by the Department of Basic Education (2011c:10) Senior Phase and these are:

Specific Aim 1:‘Doing Science’

Learners should be able to complete investigations, analyse problems and use practical processes and skills in designing and evaluating solutions. (DBE, 2011c:10).

Learners plan and do simple investigations and solve problems that need some practical ability. Attitudes and values underpin this ability. Respect for living things is an example of attitudes that need to be developed. Learners should not damage plants and when they examine small animals, they should care for them and release them back into their habitat.

Specific Aim 2: 'Knowing the subject content and making connections'

Learners should have a grasp of scientific, technological and environmental knowledge and be able to apply it in new contexts. (DBE, 2011c:10).

The main task of teaching is to build a framework of knowledge for learners and to help them make connections between the ideas and concepts in their minds. This is different from learners just knowing a lot of facts. When learners do an activity, questions and discussion must follow and relate to previously acquired knowledge and experience.

Specific Aim 3: 'Understanding the uses of Science'

Learners should understand the uses [illegible] Sciences and indigenous knowledge in society and the environment (DBE ; 2011c:10).

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Science learnt at school should produce learners who understand that school science is relevant to everyday life. Issues such as improving water quality, growing food without damaging the land, and building energy-efficient houses are examples of everyday applications. Science and Technology can lead learners to a range of career and job possibilities. An appreciation of the history of scientific discoveries and technological solutions, and their relationship to indigenous knowledge and different world views, enriches our understanding of the connections between Science and Society.

The Department of Basic Education (2011c) further states clearly that in learning Natural Sciences, learners should be assisted to develop important cognitive and practical process skills such as accessing and recalling information, observing, comparing, measuring, sorting and classifying, raising questions, predicting, hypothesizing, planning investigations, carrying out investigations, recording information, interpreting information, and communicating in different forms such as written, oral and visual ways in making information available to the people. The Department of Basic Education (2011c) also underscores the importance of Science learners' mastery of the scientific process. The scientific process involves identifying a problem, forming a hypothesis, designing an activity or experiment, observing and making conclusions.

In terms of content, the Natural Science Curriculum at the Senior Phase is based on four knowledge strands namely Life and Living, Matter and Materials, Energy and Change as well as Planet Earth and Beyond. The Department of Basic Education (2011c: 9) states that:

> Each knowledge strand is developed progressively across the three years of the Senior Phase. The Knowledge Strands are a tool for organising the subject content. When teaching Natural Sciences, it is important to emphasise the links learners need to make with related topics to help them achieve a thorough understanding of the nature and connectedness in Natural Sciences.

It is the duty of the Natural Sciences educator to ensure that the knowledge strands are adequately developed and the connectedness emphasised.

On assessment, the Department of Basic Education (2011c) places emphasis on formal and informal assessment. Assessment is viewed as the 'continuous and planned process of identifying, gathering, interpreting and diagnosing, information about the performance of learners.' The educator has to constantly ascertain the mastery of content, concepts and skills. Informal assessment takes form of regular class work and practical work and work done orally or in written form, individually or in groups. On the other hand, formal assessments are planned tasks such as tests, projects and practical exercises, whose marks are recorded and contribute to summative assessment. Of importance is aligning assessment to cognitive levels from low order to higher order questions. The educator should be able to vary questions when assessing learners' work.

The CAPS document (Department of Basic Education, 2011c) forms the basis of Natural Science teaching and learning at the Senior Phase level in the South African Education system. Science educators should understand aims of the Natural Science curriculum, its content, as well as teaching, learning and assessment approaches.

Table 3 below gives a summary of the focus of literature surveyed and the key authors who provided the literature as well as publication dates.

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Table 3: Summary of Focus of Literature Surveyed, Author and Year

FOCUS	AUTHOR	YEAR
Importance of Science as a subject	Simala Yore and Treagust Hanuscin veHian Van Driel,Beijaard& Verloop ICSU	2001 2006 2009 2001 2011
Science teaching approaches	Kischmer et al Cimer Tytler Amos Liang & Richardson	2006 2007 2002 2002 2009
Teacher preparedness in science teaching	Muwanga Zake Wang and Fwu	2001 2007
Leaners interest and science learning	Dawe Jun and Pow ROSE Project Osborne & Collins La-fifi &Pow	2003 2011 2004 2000 2011
Leaners background and learning of science	Reddy Brigido et al Lan & Tan Schaffer Mokgwa & Msila	2004 2009 2008 2007 2013
Resources and science teaching and learning	Bransford et al Idiaghe Mudulia Boohan Orji	2000 2014 2012 2002 2006
Previous studies on the teaching and learning of science in schools	Mdakane Muwanga Zake OECD Shukla et al Fricke, Horak, Meyer, & Van Lingen	2007 2004 2008 2005 2008
Teaching and learning in rural schools	Webb	2009
The South African Education System	Department of Basic Education	2011

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2.14 SUMMARY

This chapter discussed the theoretical framework and reviewed related literature. Theoretical framework showed the theory that underpinned the study. Review of literature provided a strong basis on which the study was built. Literature was reviewed on the importance of science as a subject, science teaching approaches, the quality of teaching and learning of science, learners' interest and science learning, learners' background and learning of science as well as the South African Education system. The next chapter looks at the research methodology.

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CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

The previous chapter reviewed literature on the teaching and learning of Science which informed the present study and identified gaps in literature which this study seeks to bridge. The theoretical framework underpinning the study was also discussed. This chapter describes and justifies aspects of the research methodology employed in the study, the research processes that structured the study and explains the logic behind the selected methods and techniques. The chapter presents the research paradigm, research approach, research design, sampling procedure, data collection instruments, data analysis, and data trustworthiness measures employed. A restatement of the research questions that the study sought to answer will put the research design and methodology into perspective. The study sought to establish the implementation of the Natural Science curriculum in rural junior secondary schools in Cofimvaba education district in the Eastern Cape province of South Africa and was guided by the following main and sub-research questions.

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Main Research Question

How is the Natural Science curriculum implemented in selected rural junior secondary schools in Cofimvaba education district?

Sub Research Questions

a) How prepared are the teachers in the teaching of Natural Science?

b) What are the teaching and learning methods employed in the teaching and learning Natural Science?

c) What are the challenges encountered in the teaching and learning of the Natural Science Curriculum?

d) How can the teaching and learning of the Natural Science curriculum be enhanced to promote scientific literacy in learners?

It is against the attempt to answer the above questions that the choice of research paradigm, research approach and research design, population and sample well as data collection instruments are explicitly discussed and justified in this chapter. The next section discusses the research paradigm for the study.

3.2 RESEARCH PARADIGM

According to Taylor, Kermode and Roberts (2007), a paradigm is a broad view or perspective of something. Weaver and Olson (2006) note that paradigms are patterns of beliefs and practices that regulate inquiry within a discipline by providing lenses, frames and processes through which investigation is accomplished. The study used the interpretive paradigm which is associated more with methodological approaches that provide an opportunity for the voice, concerns and practices of research participants to be heard (Cole, 2006; Weaver & Olson, 2006). The interpretive paradigm grew out of the philosophy of Edmund Husserl's phenomenology and Wilhelm Dilthey's and other German philosophers' study of interpretive understanding called hermeneutics (Mertens, 2005 cited in Mackenzie & Knipe, 2006). The study used this paradigm because it allows for the eliciting of the views of educators and learners on factors affecting the teaching and learning of Natural Science. Cole (2006) states that in the interpretive view, data in a study is based on descriptive, explanatory, and contextual words of interviewees. Cohen, Manion and Morison's (2007) definition of the interpretive paradigm as an attempt to understand individual interpretations of the world around them is therefore, consistent with the study focus. The interpretive paradigm works directly with experiences and understanding the theories that emerge as more information becomes generated during the research process. The research sought to understand the participants' experiences regarding Natural science teaching and learning in the classrooms in rural schools. Learners' active involvement in the lesson and their experiences were considered in the lesson observation. This paradigm is characterised by a concern for the individual as it seeks to understand the subjective world of human experience (Cohen, Manion & Morrison, 2007).

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Interpretive research assumes that knowledge of reality is gained through social constructions such as language, consciousness, shared meanings, documents, tools and other artefacts (Klein & Myers, 1999). Andrade (2009), Cavana, Delahaye and Sekaran (2001) as well as Mingers (2001) explain that an interpretive researcher's ontological assumption is that reality is socially constructed by humans through their actions and interactions and the researchers becomes the vehicle by which this reality is revealed.

The interpretive research paradigm allows the focus of the researcher to be on the understanding of what is happening in a given context (Mertens, 2005). Mertens (2005) further posits that the researcher and the participants are joined in a cooperative process suggesting a more personal and collaborative way of data collection. The interpretive paradigm enabled the researcher to see things through research participants' perspectives (Cohen, Manion & Morrison, 2007). In the present study the researcher met and interacted with key role-players in the implementation of the Natural Science curriculum in an attempt to understand issues from the participants' point of view. Real classroom situations were observed as Natural Science was taught in rural contexts.

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3.2.1 Justification for an interpretive paradigm

The interpretive paradigm was considered relevant for this study as I sought to understand the experiences of the participants. I gathered experiences and interpreted them to determine how Natural Science curriculum is implemented in rural junior secondary schools. Through interpretive paradigm I was able to share the feelings and interpretations of the research participants and understand their viewpoints.

3.3 RESEARCH APPROACH

There are different research approaches, qualitative, quantitative, and mixed methods. The research used a qualitative approach. Creswell (2002) defines qualitative as an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The researcher builds a complex, holistic picture; analyses words, reports participants' views in detail in a natural setting. Qualitative researchers believe that there are many dimensions underlying the approach so they look at the depth of the problem (Leedy & Ormrod, 2013).

Brown (2008:22) states that:

> In contrast to quantitative research in which control and prediction of variables takes precedence by means of measurement and quantification, in qualitative research meaning and significance of themes take precedence by means of first-hand experiencing and participating.

I utilised a qualitative approach in order to seek understanding from those involved in the implementation of the Natural Science curriculum in rural junior secondary schools. I employed this approach observe and probe the factors that promote or hinder the teaching and learning of science. According to Cresswell (2008), Hammersley (2002) as well as Van Rensburg & Smit (2004) qualitative method is characterised by concern for context, natural setting, descriptive data, emergent design and inductive analysis. In this study I engaged in lesson observations and conducted interviews to gather information, since the study sought an in-depth understanding of the issue from the point of view of participants. Cresswell (2008) states that characteristics common to several qualitative methods that may be helpful to review include: research being often conducted in the field, allowing direct interaction with the people being studied in their context, researchers collecting data themselves, reviewing it and making sense of it by organising it into categories or themes. The data collected for this study was presented in detail with direct quotations from respondents' personal perspectives and experiences. This enhanced the credibility of the study as respondents shared their experiences.

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According to Creswell (2002) qualitative research is an inquiry process of understanding that explores a social problem where the researcher conducts the study in a natural setting and builds a complex holistic picture by analyzing the words and giving a detailed, rich description of the views of informants.

There are quite a few reasons why this study follows a qualitative approach, as opposed to quantitative research. The interpretivist paradigm, within which this study is located, generally operates using predominantly qualitative methods (Silverman, 2000 as cited in Mackenzie & Knipe, 2006), therefore this study incorporates some of the basic characteristics of the qualitative research paradigm such as the fact that qualitative research usually involves fieldwork where the researcher has to physically visit the selected site and the research participants in order to conduct the interviews in their natural settings (Johnson & Christensen, 2004). In this study, I personally visited schools to interact with participants and collect data on the teaching and learning of NS in selected rural schools.

3.3.1 Justification for a qualitative approach

As already stated, the study adopted a qualitative approach and as Maykut and Morehouse (1994:46) state:

> The data for qualitative inquiry is most often people's words and actions and thus requires methods that allow the researcher to capture language and behaviour. The most useful ways of gathering these forms of data are participant observation, in-depth interviews, group interviews, and the collection of relevant documents.

A qualitative approach was very important for my study because the researcher after building a holistic picture of the study [illegible] to analyse words from the interviews and give detailed views of the respondents. Data collection involved close contact between the researcher and the participants and then it allowed the researcher to gain valuable insight into various issues around the implementation Natural Science curriculum. I physically visited the selected sites and observed even the environment they were working in. Using qualitative approach enabled me to gather rich qualitative data from the participants' narratives on different issues around the teaching and learning of NS.

It was the purpose of the study to establish the implementation of the Natural Science Curriculum from school principals, science educators and science learners' points of view hence the need to embark on an investigation using methods such as in-depth interviewing, and observation. As Flick (2002) states, a qualitative approach was found useful in in bringing out richness and depth in an inquiry.

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3.4 RESEARCH DESIGN

A research design is a plan or blue print of how the conduct of the research will proceed (Mouton, 2001). McMillan and Schumacher (2001) define design as the plan for selecting the subjects, research sites, data collection method, data analysis method and how data is presented to answer research questions. The study followed a case study design. Gillham (2000) defines a case study as an investigation to answer specific research questions which seek a range of evidences from the case settings. Gerring (2004:241) points out that a case study is:

> ... an intensive study of a single unit for the purpose of understanding a larger class of (similar) units.

The study was an in-depth investigation of school principals, educators' and learners' views and experiences on the implementation of the Natural Science curriculum. Understanding views and experiences of selected educators and learners in selected schools provided insights into views and experiences of educators and learners in similar situations. Baxter and Jack (2008) observe that qualitative studies provide the means to study complex phenomena within their contexts. In the study, educators and learners were studied in the rural school contexts in which they operated. According to McMillan and Schumacher (2001), a case study examines a bounded system or a case system or a case overtime, in detail, employing multiple sources of data found in the setting. All the collected evidence is collated to arrive at the best possible responses to the research question(s) which allows for a sharpened understanding of phenomenon which may even inform future research.

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Yin (2003) defines a case study as an empirical inquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly defined. Yin (2003) also argues that a case study approach is suitable for a study whose focus is to answer the 'how' and 'why' questions; as was characteristic of this study.

The research design, however, must suit the nature of the research being undertaken (Saunders, Lewis & Thornhill, 2003). Bogdan and Briklin (2003) also note that a design in research is a plan on how to proceed with the research process and serves to link between research questions and the implementation of the research. Most importantly, it shapes the ethical protocols within which the study is done (Kasenga, 2007). My study followed a case study design because this design enabled a systematic way to collect data and give a deeper understanding of how Natural Science educators and learners saw and experienced the teaching and learning of the subject. The design helped in answering the how, why and what questions. I was able to get a detailed description on how educators implemented the curriculum in their schools. I visited classrooms to observe the educators while conducting the lessons in order to establish if all the skills expected and specified by the policy documents were implemented in the lesson. Educators and learners were studied in the rural contexts in which they operated.

3.4.1 Justification for a case study design

Using a case study design was considered suitable for the study as it afforded the researcher to understand the experiences of teachers who implemented Natural Science in their schools. I managed to obtain different perspectives during the interview process and this provided the study with the rich information concerning the implementation of Natural Science curriculum. The case study was also considered very important for the study as I was able to analyse the case in its broader context, which is educators' background in science and learners' background in science.

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3.5 POPULATION AND SAMPLING

Maree (2005) defines sampling as the process used to select a portion of the population for the study. Delport, Strydom and Fouche (2005) define sampling as a measurement drawn from a population in which the researcher is interested in. It assists the researcher to explain the facet of the population. I employed purposive sampling to select participants for this study. Purposive sampling is the selection of information, rich cases for an in-depth study, using participants who are knowledgeable about the phenomenon under investigation (McMillan & Schumacher, 2001). The sample of the study was three principals, three science teachers, and six learners in each of the three selected rural schools. These were male and female participants, without any gender bias.

There are basically two sampling procedures namely; random and non-random sampling. Random sampling techniques give the most reliable representation of the whole population, while non-random techniques, rely on the judgement of the researcher or an accident and cannot generally be used to make generalizations about the whole population (McMillan & Schumacher, 2001).

Leedy and Ormrod (2013) argue that qualitative researchers tend to select a few participants who can best shed light on the phenomenon under investigation, rather than sample a large number of people with the intent of making generalizations. Purposive sampling is the non-probability sampling that was employed to identify the schools as well as the primary participants of this study. The targeted schools selected were rural schools and the participants were major players in the teaching and learning of NS.

Another reason for selecting this method was the fact that purposive sampling through human instrumentation increases the range of data exposed and therefore maximizes the researcher's ability to identify emerging themes that take adequate account of contextual conditions and cultural norms (Gray, 2004). The researcher saw purposive sampling as the one that fitted very well in the study as it allowed the use of a few participants so that it can be easy to identify the emerging themes.

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3.5.1 Justification for purposive sampling

Purposive sampling was considered suitable in selecting participants for the study because it allowed the researcher to select participants who were able to share rich information required for the study. Selecting the principals, teachers, learners benefited the study because the researcher was able to obtain information from the principals first as they are the ones who are accountable for everything in schools. Educators are the ones implementing, they were able to provide the researcher with their experiences in implementing the Natural Science curriculum. Creswell (2008) advises that participants in a phenomenological study need to be individuals who have experienced the phenomena otherwise it may be difficult to conduct the study. Learners also shared their experiences as recipients of the curriculum. The researcher saw the purposive sampling as a good approach that allowed the selection of participants who would provide rich data as they were directly involved in the implementation of the NS curriculum. Table 4 gives a summary of the research participants.

Table 4: Breakdown of research participants

Participant type	Sample type	Number of participants
School Principals	Purposive	3
Natural Science teachers	Purposive	3
Natural Science Learners	Purposive	18
Total number of participants		24

As shown on the Table 4, 24 participants were purposively sampled to participate in the study. These are information rich sources directly involved in the teaching and learning of Natural Science in Schools. Principals were instructional leaders who offered leadership in the teaching and learning of Natural Science, teachers were responsible for the actual teaching of the subject and learners were participants in the learning process.

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3.5.2 Selection and description of research sites

The study targeted rural junior secondary schools as the researcher sought to establish the implementation of the Natural Science curriculum in rural contexts. The researcher collected data in three different research sites all under Cofimvaba district. The two research sites were in quintile 2, while one was in quintile 1. South African public schools are categorised into five quintiles for purposes of the allocation of financial resources. Quintile 1 is made up of the poorest schools and Quintile 5 is made up of the well-resourced schools. Because of the poverty levels schools in Quintile 1, 2, 3 have been declared no fee-paying schools while schools in 4, 5 are fee paying schools. The research sites chosen for this study were under-privileged. They were remote areas also very far from town. The research sites were in predominantly illiterate and semi-literate rural communities. The three sites, in terms of the infrastructure, had formal buildings and mud classrooms, and there were no specialist rooms like NS laboratories and libraries. Two research sites did not have water sources and depended on buying water to fill in their tanks. One had a water tap as a source of water. Despite all the challenges all the three research sites had electricity.

3.5.2.1 School A

The school was established in 1976, in the Lukolweni location under the district of Cofimvaba. The distance from town is forty five kilometres. The school belongs to quintile 2. The school has nine teachers including the grade R teacher and one non-academic staff member. General qualification of teachers was Senior Teachers Diploma, Primary Teachers Diploma and Advanced Certificate in Education Management. The total number of learners was one hundred and seventy two; the grades were starting from grade R to grade nine. There were nine learning areas offered by the school and were; English, Xhosa, Maths, Natural Science, Social Science, Life Orientation, Technology, Economic Management Sciences, Arts and Culture. Computer was an extra subject to give learner's computer skill at an early age and to motivate them. The number of classrooms were ten, four is department formal structure and six mud structure. The number of learners per class was nineteen to twenty learners. There were no specialist rooms except the one for computer laboratory and it was a classroom before it was converted to a computer laboratory. The school used water tank as a source of water, they bought water to fill in their tanks. The school had electricity. The school was located in an area had had a combination of illiterate parents and learned parents and these were generally very poor parents hence he school was deemed 'a no fee-paying school'.

3.5.2.2 School B

The School was established round about 1925, it was a missionary school, at Nyalasa location under Cofimvaba district. The distance from town to the school is 50 kilometres. The school belonged to quintile 2.The number of teachers was ten. The general qualification for teachers was B.ED and STD. The number of learners was one hundred and twenty one. The classes were starting from grade R to grade nine. Learning areas offered were Xhosa, English, Maths, NS and Tech, life orientation, geography, technology, social science, Arts and culture. There were twelve classrooms. Number of learners per class was ranging between fifteen and twenty learners. There were no specialist rooms in the school, and they used tap as

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water sauce. Electricity was available and the nature of parents was illiterate. The school belonged to no fee school.

3.5.2.3 School C

The school was established in 1975 in the location of Qwebeqwebe in the district of Cofimvaba. The distance is seventy five kilometres from town to the location. The school belonged to quintile 1.There were twelve teachers and one grade R teacher, making up thirteen staff members. The general qualification for teachers was B.Ed, STD and PTC. The total number of learners was 471. Grade started from grade R to nine offering the same subjects offered by the above schools. There were ten classrooms which had formal structure, mud structure and two temporal plank structures. The number of learners per class ranged between fifty-three and sixty learners and classes were overcrowded. There were no specialist rooms, and for water source they used water tanks which they paid to refill.

3.5.3 Detailed Description of Research Participants

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This section gives a detailed description of the research participants for the study.

3.5.3.1 Principal School A

The Principal of school A is a male and he joined the service in 1988 as a teacher. He holds a Senior Teachers Diploma and also has Advanced Certificate in Education Management. He became the Principal in 2002, and has 13 years' experience as school principal.

3.5.3.2 Science Educator School A

The grade 8 Natural Science educator was female and joined the service in 1994. She trained at a college of Education, and specialised in IsiXhosa, English, Physical Science and Maths. Her qualifications were Senior Primary Teachers Diploma, Further Diploma in Education Management. Currently, she was doing a Bachelor of Education (B.Ed) honours in special needs. She had 20 years' experience and had attended professional development courses in Maths, Science for intermediate phase by Bridge IT. She was not computer literate.

3.5.3.3 Science Learners School A

The grade 8 science learners' age ranged between 15 and 16 years. There were four girls and two boys who participated in the focus group interview. Their ability in class was promising; according to their teacher.

3.5.3.4 Principal School B

The male principal joined the service in 1994 as a teacher and trained at a training college of education in 1991. His held a Senior Teachers' Diploma and Further Diploma in Education Management specialising in Biology and History. He became a Principal in 1997, and has 17 years' experience as school principal.

3.5.3.5 Science Educator School B

The male science teacher joined the service in 1998 having trained for a teacher's diploma in 1993 at a training college of education. He obtained Senior Teachers Diploma specialising in English, Xhosa, Maths, and Science. He had 21 years of experience as a teacher and had attended a professional course called Letsima, a project that was promoting Maths. Although he didn't have a certificate in computer literacy, he was able to use it in terms of writing lesson plans and other things.

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3.5.3.6 Science Learners School B

Most of the learners joined the school in 2007 and their age was between 15 and 16 years. There were three boys and three girls.

3.5.3.7 Principal School C

The female principal joined the service in 1988 as a teacher and had 26 years' teaching experience. She trained at a college of education for a Primary Teachers' Diploma, and B.Ed. specialising in Life Orientation, and IsiXhosa. She had one year experience as a principal.

3.5.3.8 Science Educator School C

The male science educator joined service in 1996, having trained at a college of education specialising in Maths and Science. He held a Senior Primary Teachers Diploma, and had 17 years' experience as a teacher. The professional development courses he attended were those of CAPS and Natural science workshops. He however, had no skills in computer literacy.

3.5.3.9 Science Learners School C

There were two boys and four girls whose average age range was 15 and 16.

3.6 DATA COLLECTION INSTRUMENTS

According to Mouton (2001:104) data may be gathered by a variety of data collection techniques. In this study, I asked probing questions, listened, analysed, and asked more probing questions to get to dee[illegible] of the conversation. Phenomena will be viewed in its entirety or holistically. I did not impose my assumptions and limitations upon emerging data. I carried out individual interviews with school principals and science teachers and focus group discussions with science learners as well as observation of science lessons.

According to Shneiderman and Plaisant (2005) interviews can be very productive since the interviewer can pursue specific issues of concern that may lead to focussed and constructive suggestions. The main advantages of the interview method of data collection are that direct contact with the users often leads to specific, constructive suggestions, they are good at obtaining detailed information and allow for few participants to gather rich and detailed data (Shneiderman & Plaisant, 2005). I worked directly in contact with participants using different instruments for data collection. Instruments that were used were individual interviews, focus group interviews and observations.

3.6.1 Semi-structured individual Interviews

This research used a semi-structured interview schedule to conduct individual interviews. The semi-structured interview is a less structured type of interview where

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the interviewer enters into the session with a plan to explore a specific topic and ask specific open-ended questions (Patton, 2002). The topics and questions are structured in an interview guide. However, the interview does not have to follow the themes or questions in the set order, and can change the wording and sequence of any question listed in the interview guide (Johnson & Christensen, 2004). The guide ensured the interview was systematic and comprehensive because of the pre-determination of the issues to be explored (Patton, 2002). I used both open and closed questions. The semi structured interviews were advantageous for my study as they allowed the participants to express themselves freely on issues regarding implementation of the NS curriculum in rural junior secondary schools.

3.6.1.1 Strengths of individual interviews

According to Shneiderman and Plaisant (2005) interviews can be very productive since the interviewer can pursue specific issues of concern that may lead to focussed and constructive suggestions. Shneiderman and Plaisant (2005) say that direct contact with the users often leads to specific and constructive suggestions and that interviews are good at obtaining detailed information and few participants are needed to gather rich and detailed data. Kvale (1996) observes that in interviews, there is personal interaction with the respondent, which means that rapport can be developed with the interviewee and the respondent may feel more relaxed and candid. They further say using of probes, interviews can shed light on the details of a particular response and interviews can be conducted in a variety of locations and times.

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3.6.1.2 Weaknesses of individual interviews and ways to overcome the weaknesses

According to Kvale (1996) interviews have some disadvantages. They are time consuming in terms of scheduling the interview, conducting the interview and inputting notes for analysis as all this takes time. In interviews error or bias may be caused by factors such as tone of voice, the way a question may be rephrased voices an opinion, inadequate appearance of the interviews may lead to errors and bias. They are also costly in terms of the amount of time required to train, schedules, conduct, input data and analyze.

Despite the challenges of the costs and distance of the research site, I managed to overcome the weaknesses. In terms of the distance I used my own transport to make it easy for me to get to the places in time. I asked the participants to sign the consent form the same day I was collecting data, I didn't use the separate day for that. I used the interview schedules which were separate because they were meant for principals, teachers and learners. The interview schedule for principals is on appendix A and the interview schedule for educators is on appendix B. Appendices C and D show the interview schedule for learners. The schedules had similar guiding research questions with different interview questions. A voice recorder was used. I stored each interviewee's responses in their separate folder so that it might not confuse the researcher when analysing data. I complemented the recording with notes where necessary.

3.6.2 Focus Group interviews

A focus group is a form of interview technique which consists of a small group of people, usually between six and nine in number, who are brought together by a trained "moderator" (the researcher) to explore attitudes and perceptions, feelings and ideas about a topic. It can lead to insights that might not otherwise have come to light through the one-to-one conventional interview. Different techniques can be used in conducting focus group interviews. There are three types of qualitative interviews as discussed by Patton (2002): the informal conversational interview, the standardized open-ended interview, and the interview guide approach. The researcher used an interview guide approach and learners in the group were asked to reflect on their learning experiences of Natural Science in the school. The interviews were conducted in English and Xhosa. The English and IsiXhosa versions of the interview guide are shown in appendices C and D respectively.

A focus group interview is less structured because of the difficulty in bringing structure in a group. However, rich data can emerge through interaction within the group, for example, sensitive issues that could have been missed in individual interviews, may be revealed. This type of interview is conducted after a series of individual interviews, to further explore the general nature of the comments from different individuals (Shneiderman & Plaisant, 2005). Maughan (2003) recommends the membership of an ideal focus group to range from six to twelve subjects. Focus

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group interviews were considered appropriate for this study as they afforded the researcher an opportunity to obtain information from learners on how they learnt the Natural Science including the challenges they faced and how these could be addressed. It allowed the learners to talk freely with the learners in the absence of their regular NS teacher.

3.6.2.1 Strengths of focus group interviews

Focus group interviews allow observations of group interaction in controlled setting (Mouton, 2001). The author also noted that they are good for less structured themes or topics. They allow the researcher to produce concentrated data on a precise topic, and they are quick and easy to conduct. The author further continue by saying participants can often exert more influence over the discussion than in one to one interview, so less of a power imbalance. They also provide rich and in depth data. Patton (2002) also notes interviewing a group often makes participants feel relaxed and willing to share their experiences [illegible] and it is not time-consuming.

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3.6.2.2 Weaknesses of focus group interviews and ways of overcoming weaknesses

Patton (2002) states that focus group has weaknesses like it relies on group interaction. It is not naturalistic because it is created by the researcher and participants may direct discussions in directions not relevant to the research and some participants may dominate discussions. I was able to convince the focus group to participate, because at first other learners were very shy to participate. In cases where they dwell much on irrelevant answers the researcher in a friendly manner remind them about the question to be answered and give them the clue of what she really mean.

3.6.3 Observation

Observation was also be used as a data collection tool. Classroom observations instruments are an organised, objective system for observing, coding, arranging and analysing the behaviours emitted by teachers and students engaged in instructional exchanges (Adler & Adler, 1998). I observed the science lessons using an observation guide shown in Appendix E, to see how teachers and learners got involved in science teaching and learning. Focus of observation was on skills taught and how students were involved in learning of science.

Observation is a way of gathering data by watching behaviour, events, or noting physical characteristics in their natural setting (Cohen, Manion & Morrison, 2007). Cohen, Manion and Morrison (2007) note that observation involves gathering live data from live situations and this is what the researcher did. I observed the lessons using an observation guide marking the information that is supposed to be in the lesson and noting down the content gap if needed and motivation words when necessary. The reason for observation was to triangulate some of the findings from educators and principals by witnessing the actual teaching and learning scenarios.

3.6.3.1 Strengths of observation

De Walt and De Walt (2002) say that observations improve the quality of data collection and interpretation and facilitate the development of new research questions or hypothesis. The researcher sees the observations as an approach that is straight forward because one will be able to see the skills that need to be implemented.

3.6.3.2 Weaknesses of observation and ways to overcome weaknesses

De Walt and De Walt (2002) share the weaknesses of observations by saying the researcher must understand that his/her gender, sexuality, ethnicity, class and theoretical approach may affect observations, analysis and interpretations. Cohen, Manion and Morrison (2007) mention other things that may affect whether the researcher is accepted in the community, including one's appearance, ethnicity, age, gender and class. Another factor they said it may inhibit one's acceptance relates to what they call the structural characteristics – that is those mores that exists in the community regarding interaction and behaviour. Some of the reasons that the researcher may not be accepted are lack of trust, the community discomfort with having an outsider there, potential danger to either the community or the researcher and the community's lack of funds to further support the researcher in the research. They continue by saying changing from one language to another that is not

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understood by the researcher, or changing the subject when the researcher arrives, or refusal to answer certain questions may really inhibit the observations. I experienced some challenges because when she was explaining the questions in home language, some learners did not understand isiXhosa deep questions, then I had to code switch back in simple English.

3.6.4 Pilot testing of research instruments

Pilot study according to Leedy and Ormrod (2013) is a brief exploratory investigation to try out procedures, measurements instruments or methods of data collection. A pilot study was with a small group of leaners in my own school for a period of two weeks in order to pre-test the instruments. Another aim was to establish if the approaches to be employed in using these instruments were really working. Once the pilot study was completed I improved the instruments and embarked on actual data collection for the study.

I pilot tested the individual interview, focus group interview and observations instruments. In the pilot study, I used only one school and on one principal, one Natural Science teacher, and one focus group of ten leaners. Both the principal and teachers were interviewed using the same questions that were used in the real study. The same interview guides meant for the study were used with the pilot group. I observed the science lesson using the same checklist used to observe the skills expected in a science lesson according to the policy documents. As shown on table 5, I aligned the data collection tools to the research questions. This was done to ensure that only data meant to answer research questions were collected.

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Table 5: Alignment of data collection methods to research questions

Research focal questions	Unit of analysis	Data collection tool	Nature of data collected
Teacher preparedness in teaching and learning of Natural Science	Principals NS Teachers NS Learners	Individual interviews Individual interviews Focus group interviews, observation	Qualitative Qualitative Qualitative
Methods employed in teaching and learning on Natural Science	Principals NS Teachers NS Learners	Individual interviews Individual interviews Focus group interviews, observation	Qualitative Qualitative Qualitative
Challenges in the implementation of the NS curriculum	Principals NS Teachers NS Learners	Individual interviews Individual interviews Focus group interviews, observation	Qualitative Qualitative Qualitative
Suggested solutions to challenges in the implementation of the NS curriculum	Principals NS Teachers NS Learners	Individual interviews Individual interviews Focus group interviews, observation	Qualitative Qualitative Qualitative

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3.7 DATA COLLECTION PROCESS

The researcher collected data using different techniques. Letters seeking consent and access were sent to the relevant offices like the District Director. I requested access to three schools falling under his district. The study was intended to be done inside the school premises during break hours and after school hours and teachers were to be used as sources of information for the topic under investigation. The other letters were forwarded to principals of the schools. Permission was sought from the Eastern Cape Provincial; Department to visit the schools to undertake this research (See Appendix H). I wanted the school principals to assist by mobilizing their staff for this study since they have influential powers over them. The schools gave me different dates to collect data and letters of acceptance to the research sites. The researcher coded the names of the school in alphabet letters in a note book in order to keep the appointment time as the schools were not close to each despite being under one district. Data were collected in all the participating schools in line with the programme for interviews and observation shown in Appendix L.

3.7.1 Individual interviews

Interviews were conducted in the Principals office and classrooms. I explained to the participants the reason for my visit to the school and explained the consent forms. In all the schools the interviews started with the principals. I used a voice recorder to capture the responses from the participants. On the other hand, I was taking notes while asking questions to the participants. In cases where they did not understand I had to explain further.

3.7.2 Focus group interviews

Focus group interviews were conducted in the classrooms and one school used an office. The interviews for focus group were voice recorded and notes were taken down for further assistance when transcribing the information. I gave all learners a chance to participate.

3.7.3 Lesson observation

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I went to the classrooms for observations. Observation was done using the observation guide shown on Appendix E. Lesson observations were not voice recorded. I was just observing and taking down notes. I used a checklist to see if the expected specific aims, approaches, resources were all included in the lesson. I also observed learners' participation in the lesson.

3.8 DATA ANALYSIS

Data analysis involves working with data, organising it, breaking it into manageable units (Mouton, 2001). Similarly, Patton (2002) views data analysis as the process of bringing order, structure and meaning to the mass of collected data for its interpretive and meaningful quality. Bogdan and Biklen (2003) also define qualitative data analysis as "working with the data, organising them, breaking them into manageable units, coding them, synthesising them, and searching for patterns". The aim of analysis of qualitative data is to discover patterns, concepts, themes and meanings.

3.8.1 Content Analysis

Content analysis was utilised to analyse the study data. In case study research, Yin (2003) discusses the need for searching the data for "patterns" which may explain or identify causal links in the data base. In the process, the researcher concentrates on the whole data first, then attempts to take it apart and re-construct it more meaningfully. Categorisation helps the researcher to make comparisons and contrasts between patterns, to reflect on certain patterns and complex threads of the data and make sense of them.

Audio-taped interviews were transcribed and I coded and categorised data to enable thematic analysis. Data were coded according to the predetermined themes from literature. New themes that emerged from the interviews were coded separately and then merged into a bigger system (Hsieh & Shannon, 2005). Data were then analyzed according to the themes that emerged. Data reduction and coding techniques were used with the aim of selecting, focusing, simplifying, abstracting, and transforming the data. Various techniques, like the creation of tables and matrices of categories, narrative text, quotation, and tabulating the frequency of different issues were used in displaying data.

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I considered Smith's (2007) advice that a good analysis is one which balances phenomenological description with insightful interpretation, and which anchors these interpretations in the participants' accounts. In order to achieve this, the interviews were recorded with the respondents' permission. The first task was to transcribe each interview. Frankham (2005) asserts that it is a good idea to try to transcribe every word of a taped interview because the researcher will not know what is relevant until he/she will analyze the data and write it down. After each interview the researcher listened to the recordings and transcribed them verbatim in order to allow for the voices of the research participants (Groenewald et al 2004).

Creswell (2008) identifies eight steps to be followed when analysing the data namely:

- Reading of transcripts to get a sense of the whole ideas coming to mind

- Reading the most interesting transcript to find the underlying meaning of participants on different aspects of the implementation of the NS Curriculum.
- Clustering similar topics together.
- Abbreviating topics and writing codes next to the appropriate segment in the text.
- Turning descriptive wordings for topics into categories and then grouping related topics together
- Allocating abbreviations for each category and then arranging codes meaningfully.
- Assembling data material belonging to each category and conducting a preliminary analysis.
- Recording existing data.

This systematic classifying and coding of data resulted in themes and sub-themes that were used to make sense of data. Verbatim quotations of the participants were captured to support themes and sub-themes.

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3.9 DATA TRUSTWORTHINESS

In line with the qualitative thrust of the study, I attended to critical issues of data trustworthiness. Creswell (2008) notes that data trustworthiness takes the place of validity and reliability associated with quantitative studies. When humans are the subjects of social research, as in this study, it is very important to assure them of trustworthiness (Leedy & Ormrod 2013; Meyers-Daub, 2003). Cohen, Manion and Morrison (2007) however, argue that validity is an important criterion for effective research and that invalid research is worthless. They claim that qualitative data validity must be addressed through the honesty, depth, richness and scope of the data gathered, the participants approached, the extent of triangulation and the objectivity of the researcher.

Lincoln and Guba (1985) propose four criteria namely credibility, transferability, dependability and confirmability, which should be addressed by qualitative researchers wishing to present a convincing case that their work is academically sound. They provide these as an alternative to more traditional quantitatively-oriented criteria and felt that their criteria better reflected the underlying assumptions involved in qualitative research.

3.9.1 What is data trustworthiness in a qualitative study?

When humans are the subjects of social research, as in this study, it is very important to assure them of trustworthiness (Leedy & Ormrod 2013; Meyers-Daub 2003). Cohen, Manion and Morrison (2007) however argue that validity is an important criterion for effective research and that invalid research is worthless. They claim that qualitative data validity must be addressed through the honesty, depth, richness and scope of the data gathered, the participants approached, the extent of triangulation and the objectivity of the researcher.

Guba and Lincoln (1985) proposed four criteria namely credibility, transferability, dependability and confirmability, which should be addressed by qualitative researchers wishing to present a convincing case that their work is academically sound. They explicitly offered these as an alternative to more traditional quantitatively-oriented criteria and felt that their criteria better reflected the underlying assumptions involved in qualitative research. Below is a detailed discussion of how the criteria were applied in the study in order to enhance the trustworthiness.

3.9.2 Credibility

Smith (2007) emphasises the truth-value of qualitative research and list a number of means to achieve this, which have all been employed in this study. Firstly, the phenomenological research design contributed toward truth. I spent extensive time on data gathering and analysis. I engaged with the data and spent considerable time analyzing it. Yin (2003) argues that qualitative methodology lacks sufficient precision, objectivity, and rigour. Therefore in order to get authentic answers I met the participants directly. Engagement with credibility issues such as cross-validation or triangulation is very important as it is likely to increase the reader's confidence (Smith, 2007). However, in a phenomenological study like this one, the respondent's "voice" is primary; therefore no triangulation will be needed (Leedy & Ormrod, 2013).

3.9.3 Transferability

Seale (1999) advocates that transferability is achieved by providing a detailed, rich description of the settings studied to provide the reader with sufficient information to be able to judge the applicability of the findings to other settings that they know. As the foundation of transferability is an adequate description of the context; the search for data was guided by the processes that would provide rich detail. This required a sampling procedure that is governed by emerging insights about what is relevant to the study and purposively seeking both the typical and the divergent data that these insights suggest (Lincoln & Guba, 1985; Creswell, 2008).

Transferability is considered a major challenge in qualitative research due to the subjectivity from the researcher as the key instrument, and is a threat to valid inferences in its traditional thinking about research data. However, a qualitative researcher can enhance transferability by detailing the research methods, contexts, and assumptions underlying the study. [illegible] enhanced transferability by providing clear details in the research methods that were employed in the study (Lincoln & Guba, 1985).

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3.9.4 Dependability

Shenton (2004) suggests that in order to address the dependability issue more directly, the processes within the study should be reported in detail, thereby enabling a future researcher to repeat the work, if not necessarily to gain the same results. Lincoln and Guba (1985) suggest that dependability can be communicated through an audit. To provide for a check on dependability, the researcher must make it possible for an external check to be conducted on the processes by which the study was conducted. According to Merriam (1998), it refers to the extent to which research findings can be replicated with similar subjects in a similar context. It emphasises the importance of the researcher accounting for or describing the changing contexts and circumstances that are fundamental to consistency of the research outcome. As a researcher I was aware that I was responsible for gathering the data and interpreting it so that I produce good quality research findings.

Merriam (1998) suggests that reliability in this type of research should be determined by whether the results are consistent with the data collected. The following techniques are provided to achieve this, explaining the assumptions and theory behind the study and explaining the use of multiple methods of data collection and analysis (triangulation), and how data was collected for an audit trail if necessary. According to Seale (1999), dependability can be achieved through auditing which consists of the researcher's documentation of data methods and decision made during a thesis as well as its end products. Auditing for dependability requires that the data and descriptions of the research should be elaborate and rich. It may also be enhanced by altering the research design as new findings emerge during data collection. I explained in detail how data were collected to make sure that the results are consistent.

3.9.5 Confirmability

The concept of confirmability is the qualitative investigator's comparable concern to objectivity (Shenton 2004). In simple terms confirmability is the degree to which the results could be confirmed or corroborated by others, especially the respondents of the study. Steps were taken to ensure that the researcher's predispositions do not influence the data or the interpretation. Seale (1999) argues that auditing could also be used to establish conformability in which the researcher makes the provision of a methodological self-critical account of how the research was done. In order to make auditing possible by the researchers, it is a good idea that the researcher archives all collected data in a well-organised, retrievable form so that it can be made available to them if the findings are challenged. I organised the data in a chronological order so that it would be easily accessibly when needed.

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Trustworthiness addresses issues of credibility, transferability, dependability and confirmability (Shenton, 2004). To address the issues of data trustworthiness, I employed measures such as;

- Member checks of interview transcripts
  Participants were allowed to read interview transcripts after the interviews in order to comment and correct on any views that were not captured properly.
- Multiple sources of data collection

The researcher used triangulation of sources and instruments. Different instruments of data were used such as individual interviews, focus group interviews and observations, in order to gather multiple perspectives on the same issue so as to gain a more complete understanding of the phenomena. Data were collected from principals, educators and learners, in an attempt to hear different views on the same issues.

- Pilot testing of instruments

  Pilot testing was conducted to test the data collection instruments used in the study with the aim of identifying weaknesses and strengths.

- Data audit

  The data auditing was used by the researcher and the study was reported in detail in order to enable a future researcher to repeat the work if necessary. The researcher allowed for an external check to be conducted checking the authenticity of the study. The researcher ensured that data collected was well organised, retrievable when needed.

- Description of research context

  As an element of data trustworthiness, a detailed description was given for the research sites and research participants. These were some of the measures taken to ensure data trustworthiness of the study.

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3.10 RESEARCH ETHICS

Anyone involved in research should be aware of the general agreements about what is ethical or unethical (Babbie & Mouton, 2005). Whenever humans are the focus of social research, ensuring that the study conforms to ethical standards is of paramount importance (Cohen, Manion & Morrison, 2007). Silverman (2000) reminds researchers that that while they are doing their research, they are entering the private spaces of their participants. Creswell (2008) states that the researcher has an obligation to respect the rights, needs, values and desires of the informants. Miles and Huberman (1994) list several issues that researchers should consider when analyzing data which include informed consent, no exposure to harm and risk, honesty and trust, privacy, confidentiality and anonymity.

3.10.1 Importance of ethics in research

McMillan and Schumacher (2001) define ethical issues as requesting permission from relevant authorities to conduct the research and gaining access to the research site. The following ethical issues will be addressed in the study. Research ethics deal primarily with the interaction between researchers and the people they study Creswell (2008) points out that the researcher should make sure that no individual suffers any adverse consequences as a result of the study. Leedy and Omrod (2013) further state that, within the social sciences, human subjects are often used in research, and therefore ethical implications need to be considered. I treated the participants with respect and the information that they shared with me was kept confidentially and participants were assured of this.

3.10.2 Informed consent

Babbie and Mouton (2005) postulate that informed consent relates to the communication of all possible information, as accurately as possible, about the research to the research participants. The first ethical concern in any research involving humans is informing the participants in the research of the advantages and risks involved in the study and obtaining their consent to participate in the study. Informed consent is a mechanism for ensuring that people understand what it means to participate in a particular research study so they can decide in a conscious, deliberate way whether or not they want to participate (McMillan & Schumacher, 2001). It is one of the most important tools for ensuring respect for persons during research. Participants were informed about the significance of the study and its purpose. School principals and science educators signed the informed consent form shown on Appendix F. Learners who participated in the study were minors and their parents or guardians had to sign the consent for shown on Appendix B on their behalf. Participants were also informed, as part of their consent that results of the study would be made available to them on request.

3.10.3 Voluntary participation and withdrawal

The respondents were told that participation was voluntarily, and that they would be free to pull out of the study at any time if they feel like doing so. I confirmed to the

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participants that classes were not going to be disturbed due to their participation in the study.

3.10.4 Anonymity and confidentiality

The respondents were assured that their responses would remain anonymous, confidential and their names would not be written even if findings were published.

3.10.5 Research Permission

A letter seeking entry to schools was submitted to the district office including letters to school principals. I forwarded letters to the schools requesting the principals to allow the study to be conducted in their schools. The letter to the Provincial Education Department was submitted asking for a permission to conduct research. Permission letter from the provincial office is shown on Appendix H. University of Fort Hare ethical clearance was sought and granted as shown in Appendices I and J. This shows that high ethical standards were adhered to.

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3.10.6 Harm and Risk

The researcher guaranteed that no participant would be put in a situation where they might be a harm and risk as the result of their participation in the study.

3.10.7 Honesty and Trust

I guaranteed to the participants that the study would be conducted in a transparent manner and results will be reported accurately and honestly.

3.11 SUMMARY

The chapter outlined the research methodology, indicating that the study was qualitative and located in the interpretivist paradigm following a case study design. This chapter explicitly described and justified all the methodological processes and procedures, including adherence to ethical considerations. The next chapter presents, interprets analyses and discusses the findings.

CHAPTER 4

DATA PRESENTATION, INTERPRETATION, ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

This study sought to establish the implementation of the Natural Science curriculum in selected rural secondary schools in the Cofimvaba education district in the Eastern Cape Province in South Africa. The previous chapter dealt with the methodological processes and procedures that were utilised in responding to the research questions. In this chapter the researcher presents data gathered using individual interviews with three school principals and three natural science educators, focus group discussions with eighteen grade eight Natural Science learners as well as lessons observed. Data is then presented using themes and sub themes drawn from narratives in an attempt to answer the sought research questions.

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4.2 THEMATIC PRESENTATION OF FINDINGS

Findings of the study in answer to the sub-research questions are presented thematically. Themes are drawn from the sub-research questions. Responses directly from the participants are given using the following codes:

Table 6: Codes for participants

PARTICIPANT CODE	FULL DESCRIPTION
PSA	Principal School A
PSB	Principal School B
PSC	Principal School C
SEA	Science Educator A
SEB	Science Educator B
SEC	Science Educator C
SLA	Science Learner School A
SLB	Science Learner School B
SLC	Science Learner School C

4.2.1 Theme 1: Educators' preparedness in the teaching and learning of Natural Science

Table 7 summarises issues raised by principals, educators and learners on sub-themes around the issue of educator preparedness in teaching NS.

Table 7: Participants' responses on educators' preparedness in science teaching and learning

Sub-theme	Issues raised
Science educators availability	• Educators were available to teach NS • There was no shortage of educators • Educators were over loaded because they teach other areas.
Science educators training	• Educators had basic teacher training • Educators could not be deemed science specialists • None held a degree in science or science education.
Interpretation of curriculum documents	• Policy documents for CAPS are the ones that inform us clearly about the content to be done. • There are specific aims we follow when teaching in the policy documents. • The policies inform us but not adequately enough, and are not clear.
Professional development of science educators	• Teachers attended workshops for NS. • Some workshops were offered by NGOs • Not many science-specific workshops at cluster or district levels • No higher qualifications in science obtained.
District and provincial support of science teachers	• Not much of subject-specific support for NS teachers through visits by officials. • They give support in schools by visiting, doing school readiness, conducting workshops, doing common tasks assessment for exams.
Natural Science Content	• CAPS served as a guide and derive the content from the policy document; however need some help in one of

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	the strand. • Some strands are familiar others not easy because they are taken from geography. • Not confident in teaching some topics which they said were difficult

4.2.1.1 Teacher availability and training

On the preparedness of educators to teach Natural Science, the participants in the three participating schools indicated numerous views related to availability of educators, nature of their training, interpretation of curriculum documents, professional development and district and provincial support. On availability of educators in the teaching and learning of NS, the principals revealed that teachers were available. On being probed about the qualification and training, principals revealed that the teachers were trained though they were not necessarily trained in teaching NS. PSA stated that, *"All [illegible]ay is that the educators are trained teachers but we do not have specialist science teachers as such."* This view of lack was further revealed by the educators themselves. SEA indicated that she had had trained at a college of Education, areas of specialisation is Xhosa, English, Physical Science and Maths. Firstly, these were too many subjects for one to major in and on being asked if during training there was much of content expertise in Science, the educator could not confirm that. The observation that none of the participating teachers held a degree in Science or Science education further confirmed that were not science specialist. However, learners indicated that their educators were knowledgeable in science. Learners' judgement of teachers is understandable at such a young age as they may be impressionistic about the educators' expertise.

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On the interpretation of curriculum documents, the principals revealed that the policy documents were guiding the teachers in the teaching and learning of Natural Science. PSB indicated that, "Policy *documents are available they serve as the bible for educators, hence they have been trained. They use these documents in implementing the curriculum."* The educators also confirmed that with policy documents available there was some guide to the way they taught NS as SEB said, *"CAPS documents inform the policies, they have things like specific aims. I am clear* *about them and it is easy to read and interpret."* The principals and educators confirmed that curriculum documents were available and that educators were able to interpret them to ensure meaningful teaching and learning of NS.

4.2.1.2 Professional development and support for educators in NS teaching

In terms of Professional development of Science educators, the participants indicated that educators were developed by the department of education and non-governmental bodies. PSB stated that, "*Teachers attended workshops for Natural science by the Department of Education and also by the NGOs."* The educators also indicated that they attended workshop and SEC said, *"I attended the professional development courses for Maths and Science that were offered by a non-governmental organisation called Bridge IT, it was a project for Maths and Science."* However, participants could not give the exact details of the frequency and nature of workshops as well as issues tackled in workshops and how they assisted them. It was clear that some workshops were [illegible], mostly on teaching approaches but these were not regularly scheduled and implemented. None of the participants indicated that they were professionally developing themselves by studying for a degree in science or science education. Given the fact that all the educators had started teaching between 1993 and 1996, it showed that nothing had been done to improve their pedagogical and content expertise.

On support offered to NS teachers, participants revealed that district and provincial officials often visited schools for supervision and ensuring compliance with set regulations. PSA said, "*District is the representative of the provincial support; they come with the face of provincial support. They do school visit, school readiness, and quarterly visits. They support by doing follow ups checking what has been done in the last term" and SEB also said, "Officials come mostly at the beginning and at the end of the term to check on what we will be doing."* On being probed if there were visits by Science subject advisors meant to support NS teachers, participants indicated that visits were mostly of a general nature.

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4.2.1.3 Natural science content

On Natural Science content participants indicated that educators had the required content to teach NS. PSB said, *"I can say educators are comfortable with the content to teach NS and they are also assisted by textbooks and the CAPS documents"* and SEB said, '*I am familiar with content, common topics are plant and animal cells, periodic table, (formation of compounds). The content is derived from policy document CAPS as a guide. I use different textbooks to add up to the lesson plan. I am not a Science expert because Science involves four strands, which I am not familiar with the fourth one Earth and beyond. I need some help in Earth and beyond."* There was a general indication that teachers were comfortable with NS content and this confidence was also shown in all the lessons that were observed. Learners also confirmed this as SLA said *"Our NS teacher is an expert, because she makes it a point that she explains things very well and clearly."* Of concern, however, is the confession by one educator that she was familiar with the NS strand Earth and Beyond. This could show that some educators had problems with content of certain sections of the curriculum and this would impact negatively on the way learners were taught as the educator is supposed to be an expert in the subject.

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4.2.1.4 Main findings on Educators' preparedness in the teaching and learning of Natural Science

The study established that educators were available and qualified to teach but were not NS specialists as none of the teachers possessed a junior degree in science or science education. Whilst educators attended workshops related to the new CAPS curriculum, there were no coordinated and regular professional development programmes for science teachers, in terms of enriching science content or pedagogical expertise. Despite many years of teaching experience, none of the educators had professionally developed themselves by acquiring academic or professional degrees in science or science education. Educators relied on workshops attended and curriculum documents available to interpret the new CAPS NS curriculum. There were still some topics in the interpretation of the NS CAPS curriculum educators required assistance in. District officials visited schools for general routine visits for supervision but there were few workshops targeting science educators.

4.2.2 Theme 2: Methods employed in the teaching and learning on Natural Science

This section presents data on participants' views on methods that were employed in the teaching and learning of NS. Table 8 summarises participants' views.

Table 8: Participants' responses on teaching and learning methods employed in the teaching and learning of Natural Science

Sub-theme	Issues raised
Educators' awareness of different teaching and learning approaches	• They are aware of the teaching approaches especially from those from the colleges. • Aware of teaching approaches. • Use some of them but still need more.
Different teaching and learning approaches employed	• They employ them in class by involving learners do research and investigations. • They use teaching resources, concrete resources. • Text book, learner/ teacher approach. • Investigations, experiments, telling methods are used by teachers.
Learner involvement in science learning	• Learners work in groups. • They do practical tasks as groups • They use text book. • In some activities they do participate. • Learners said they understood because they often got high marks during exams. • Worked as groups and did work in small groups.
Activities employed in science teaching and learning	• Investigations/experiments • Projects • Making models • Practical tasks
Usefulness of teaching and learning approaches in science	• Approaches are useful but needs some improvement. • Approaches were useful to some extent. • Discovered that others enhance learning. • After teaching them they are able to do hands on. • Linking of concepts to what learners already know

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4.2.2.1 Educators' awareness of different teaching and learning approaches

Participants revealed that educators were aware of the different teaching and learning approaches to be employed in the teaching and learning of NS. PSB said, "*They are aware of the different teaching approaches and methods. Sometimes as I have been mandated to visit the classrooms they really use them e.g. Investigations and make learners work on their own in many different ways, as much as I am not very much well versed in the field of Science."* The educators also confirmed this and ESC said, "*Yes I know group work; do not understand the one using computer. I am not used and never trained for computer. Most of the time I do telling method."* Educators' awareness of different teaching approaches was confirmed by learners as SLB said, *"We work as groups' e.g. After finished writing the presentation of the group one learner in the group goes in front of the classroom to present what we were discussing."* It was clear from the responses that educators had an awareness of different teaching and learning approaches.

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4.2.2.2 Different teaching and learning approaches employed

On different teaching and learning approaches indicated that educators actually employed different teaching and learning approaches. PSA said, "*With the old system they use teaching resources, concrete resources; in the absence of teaching they use real objects like leaves, grass. They are doing it to their best. They also use learner centred approach, student involvement. They are useful but not hundred percent."* On the same issue, *SEC said, "I normally do experiments with learners, I allow them to carry out investigations and I also use the textbook method; I rely on text book since we lack resources."* On further probing, from educators how often they employed learner-centred approaches in their teaching, the educators indicated that the use of language of instruction and lack of resources made them end up using teacher centred approaches. In lesson observed, the educators made use of group work and it was noted that learners use their mother tongue in groups and also struggled to report back group activities in English. It was clear from the participants' responses that different teaching and learning approaches were employed but there were problems that made the use of some learner-centred approaches impossible such as lack of resources. Educators also revealed that they attempted to linking new science concepts to what learners already knew and this is an important and useful aspect of teaching and learning.

4.2.2.3 Learners' involvement in science learning

Concerning the student involvement in science learning the participants revealed that educators involved learners in NS learning. PSC said, "I always see educators trying to let *learners to work as groups and at times they do practical tasks" and SEB said, "I involve learners using text book method."* Learners themselves confirmed being actively involved in learning as SLB said, *"We participate but it is not easy because we do not do some of the things since we do not have resources."* 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.

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4.2.2.4 Activities employed in science teaching and learning

On actual activities employed in the teaching and learning of science Investigations, participants indicated activities such as projects, making of models, practical tasks and carrying out of experiments were employed. SEA said, *"Learners work on some related activities like investigations and I also involve them in science projects" and one SLA also confirmed, "We do not do projects."* However, when educators were probed on how often they employed activities such as projects and experiments, they indicated that lack of resources was a problem. SEB said, *"It becomes a problem when you don't have materials learners need to use, learning simply becomes theoretical."* It was interesting to find out educators used different activities all meant to enhance learners' understanding on NS concepts, though there were some challenges.

4.2.2.5 *Usefulness of teaching and learning approaches employed in science teaching*

On the usefulness of teaching and learning approaches employed in science teaching, participants indicated that the current approaches employed were useful some extent. PSC said, *"Current approaches used by educators are useful at times but require improvement given better conditions and resources" and* SEC said, "*I discovered that other approaches enhance learning while others do not. Mostly, learners need to be involved in practical work in order to understand science concepts. I often allow them to do practical work where possible."* Learners also supported the usefulness of current approaches employed as SLB said, "*We understand when the teacher is teaching, we listen to our teacher and we also ask questions when we do not understand. We see that we have understood when we score high marks in tests."* From the participants' views, though current approaches were useful there was room for improvement.

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4.2.2.6 *Main findings on methods employed in the teaching and learning on Natural Science*

It was established from the participants' views that educators were aware of the different teaching and learning approaches. Educators also attempted to involve learners in the learning of different concepts by use of learner centred approaches and this was confirmed by the learners themselves. However, because of lack of resources, educators did not always involve learners in learning and would resort to the telling method. Approaches such as group work and experiments were employed. Educators also attempted to link NS concepts to what the learners already knew.

4.2.3 Theme 3: Challenges encountered in the teaching and learning of Natural Science

This section presents information on participants' responses on challenges encountered in the teaching and learning on NS. Table 9 is a summary of the participants' views.

Table 9: Participants' responses on challenges encountered in the teaching and learning of Natural Science

Sub-theme	Issues raised
Resources in NS teaching and learning	• Resources not available. • No science kit. • No laboratories in the schools. • science textbooks are insufficient
Learners' background and science learning	• Background affected on a large scope. • Lack the background because of the environment. • Some learners lived with illiterate parents/guardians. • Poor background inhibits the learning of science.
English as medium of instruction/ the language of science	• Language is not easy for them to communicate. • Introduction of MTBB made it easy for learners to understand science concepts. • Learning negatively affected by the use of English. • Learners had problems in understanding some scientific terms and processes • Educators often resorted to code switching. • Learners' had problems in expressing themselves in English, often allowed to speak in mother language. • There are difficult concepts that we do not understand they need to be explained in Xhosa.
Time allocated to NS	• NS is so wide, time is a challenge. • Work load, not able to finish at the expected time. • Not adequate, there is more work and few hours. • Not satisfied with the time allocation because there is a lot of work.
Support from parents	• Parents could not assist their children financially and materially • Parents/guardians could not assist their children academically. • They help us in the activities that they understand.

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Other challenges in the teaching and learning of NS	• Absence of learners due to environmental factors. • Negative attitude of learners • Overcrowded classes. • Indiscipline of learners.
Measures to address challenges	• Ordered the resources since the DoE this year forwarded the catalogue to do so. • DoE must build schools; there are not enough space due to the overcrowded classes. • Trying to involve parents of the learners, community to help. • Involve learners in sport activities. • Using extra mural activities to help the learners

4.2.3.1 Resources in NS teaching and learning

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On the issue of resources in the teaching and learning of NS, participants raised that lack of resources was a challenge that hindered the proper and meaningful teaching of the subject. Lack of proper infrastructure such as classrooms, laboratories and libraries negatively affected teaching and learning. PSA said, "*Resources are not available. We do not have a science laboratory in which to carry out the teaching and learning of science." The issue of laboratories was raised educators who further stated that there was no enough classroom space as SEB said, "We don't have a lab and our classrooms are too crowded with learners and this affects our teaching." Learners also confirmed infrastructural challenges as SLC said, "In this school we do not enough classrooms, we do not have a library and we do not have computers."* This lack of basic and required infrastructure showed serious challenges affecting the teaching and learning of NS in rural schools.

Participants also indicated the severe presence of material resources such as adequate NS textbooks, apparatus, chemicals and other equipment. PSB said, "*We do not have adequate materials such as apparatus and science kits. Children learn science without ever touching a microscope."* The same views were shared by educators as SEC said, "The t*exts books that we have are very few and they are not in line with the new CAPS curriculum requirements."* SLA also raised the same point by saying that, *"We do not have good and enough text books."* Teaching and learning of NS becomes a real challenge in a situation where basic requirements such as textbooks, science apparatus and equipment are not available.

4.2.3.2 Learners' background and science learning

On how learners' background affected their learning of science, participants in some ways found science concepts difficult due to lack of exposure. PSC said, "*That is a challenging on the fact that we are in these Bundus (bushes), background negatively affects in a huge way. Most of the things taught at school are foreign to learners as they would have not seen or experienced them." Educators also had similar views as SEA also said, "It affects them in many ways, some live with grannies who are uneducated. Sometimes you teach something that is not in their community, they do not have any idea about, it gives a problem." Learners also confirmed that some of the concepts learnt in NS were unfamiliar to them as SLA said, "We are interested in things that are happening generally [illegible] but we experience challenges in science concepts we do not understand."* It was, therefore, clear from the participants' insights that learners encountered some challenges in understanding some NS concepts because of the rural and disadvantaged backgrounds.

4.2.3.3 English as medium of instruction/ the language of science

Participants also indicated that the use of English as a medium of instruction was a challenge in NS teaching and learning. Learners were English second language speakers who had problems in communicating in English and this was worsened by having to deal with a complex scientific language. PSB said, *"Learners find it difficult to speak and understand English because this school is in a remote rural area and English is never used in this area. Teachers have to resort to code switching when teaching."* The researcher experienced educators code-switching in all the observed lessons. In a lesson in school A the educator was explaining solution formation of solutions by mixing solutes and solvents and would code-switch in an attempt to make learners understand the concepts solute, solvent and solution. In asking questions, educators often translated questions into IsiXhosa and one of the educators encouraged learners to respond in their mother tongue as they were not comfortable responding in English. The researcher also observed learners speaking

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to one another in their mother tongue as they worked on group tasks given. Educators confirmed challenges in the use of English as a language of instruction and SEC had this to say, "*There are science terminologies that are very difficult for learners to understand and this becomes a source of learning barrier. The solution is to code switch.*" Learners also revealed that their desire to learn NS was negatively affected by their failure to understand some of the concepts as they were taught in English. SLC said, *"Yes use of English at times makes us fail to understand what will be taught but luckily our teacher always explains in Xhosa to make us understand."* Use of English as a language of instruction together with science terminologies were revealed to be real challenges affecting the teaching and learning of NS.

4.2.3.4 Time allocated to NS lessons

Regarding time allocated to NS lessons, participants revealed that the time was not enough to cover all aspects of the subject. PSB said, "*Time has always been a challenge; NS is so wide, there are many topics to be covered and a lot to do on each topic. Time is very limited, the teacher has to rush they cannot finish the things because of time constraints.* The educators also shared the same viewpoint as SEC said, "*No the time it is not adequate, there is more work in a term. The work is more and time is limited.*" Similarly, the learners also felt time was not enough as *SLB said, "Time is not enough because sometimes we will be learning a difficult topic and the teacher does not spend much time on it because there are other topics to be covered."* Participants showed that inadequacy of time negatively affected the teaching and learning of NS.

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4.2.3.5 Other challenges in the teaching and learning of NS

Participants also raised some other challenges in the teaching and learning of NS such as learner absenteeism, learners' negative attitudes towards school and learner indiscipline. PSC said that, *"School attendance by most learners is very irregular and with frequent absenteeism some learners are always behind with their work."* SEA also said, "*Most of the learners here do not take their lesson seriously. If you give them work to do, some of them do not do it. It's an issue of wrong attitudes." SEC also said, "Some of the learners run away from school and some have no respect for educators. We are not allowed to beat them, we just have no solution to such* *problems."* It was clear from the insights of principals and educators that there were challenges associated with learners themselves that negatively affected learning in the schools.

4.2.3.6 Measures to address challenges

Participants were also required to share with the researcher what they were doing to address some of the challenges that they faced in the teaching and learning of NS. PSA said, "*We try to involve parents in the learning of their children by calling them for meeting so that we explain to them the need to support the school but this is not always successful as some may not even come for meetings."* SEB said that, *"I always create extra time for my learners by coming early to school and leaving late so that I have more time with them"* and SEA said, *"When I have a learner who is totally neglecting his or her school work or is misbehaving, I normally call in the parent to talk about ways to assist the child at school and at home."* In the light of the challenges they faced in the teaching and learning of NS, principals and educators always tried to find solutions.

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4.2.3.7 Main findings on challenges encountered in the teaching and learning of Natural Science

It emerged from the participants' responses that there were challenges of resources in schools and these impacted negatively on the teaching and learning of science. The realisation that schools did not have laboratories, science equipment and adequate textbooks points to serious problems in effective science curriculum implementation. Another key finding of this study is that learners' background and the use of English as LoLT also negatively affected the teaching and learning of science. Lack of parental support was also another challenge. It also emerged from the study that time allocation for NS was not enough to cater for all the theoretical and practical work involved. Some challenges were related to learner absenteeism as well as lack of cooperation with teachers.

4.2.4 Theme 4: How the implementation of the Natural Science curriculum could be enhanced to promote scientific literacy in learners

This section presents information on participants' views on how the implementation of the NS curriculum could be enhanced. Table 10 summarises the participants' views.

Table 10: Participants' responses on ways of improving implementation of NS curriculum

Sub-theme	Issues raised
Role to be played by the school administrators and governors.	• Ensure provision of school laboratory • Make available required resources
Role to be played by DoE	• Give bursaries to develop teachers. • Visit schools for support and supervision
Role to be played by educators	• Forming of groups to assist each other. • Work as a team • Professionally develop themselves
Role to be played by parents.	• Work hand in hand with school authorities. • Support their learners. • Work hand in hand with teachers. • Must visit school.
Role to be played by learners	• Learners must take their work seriously • Learners must minimise absence in school.

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4.2.4.1 Role to be played by the school administration to enhance teaching and learning of NS

On what could be done by the school administrators and governors in enhancing the teaching and learning of NS, participants indicated the need to spearhead the provision of laboratories and other resources. PSA said that, *"We need to get funding to construct a laboratory in the school so that our learners can experience real learning of science."* And SEC said, "*They must organise enough materials e.g. books, laboratory, science kit that could enhance the teaching and learning of NS." Learners also had the same views with SLA saying "They must buy resources and they must organise a specialist room for science only."* It was clear from the participants that school administrators and governors had a huge role to play in providing infrastructure and materials resources to enhance the teaching of NS.

4.2.4.2 Role to be played by DoE

The participants also indicated that the DoE had a role to play in supporting educators to professionally develop themselves as science specialist as well as visiting schools to supervise and support science educators. PSB said, "*As NS is the one of the most important subjects, I believe the DoE may also as well consider the time factor and forward to upper structures. It will be proper the DoE to visit the schools. They must give support to schools by giving training and workshop*" and SEA said, "*If they can give me bursary to learn, and also develop other teachers in NS. Teachers are eager to learn more to become experts in their subjects*". Even learners felt DoE should do something as SLC said, "*If only the government can build us a laboratory like in other schools in town, we will be happy.*" Participants revealed that there was some work to be done by DoE to ensure improvement in the teaching and learning of NS.

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4.2.4.3 Role to be played by educators

Educators were also said to have a crucial role to play in the improvement of the teaching and learning of NS. *PSA said, "It is important for educators to continue to upgrade themselves through in service training and taking up curriculum courses, this will make them better educators"* and the teachers themselves felt the same as SEA said, *"If we can get science experts from other schools to visit us and motivate us and show us new approaches that we can use. The experts must come and service us and it will assist us a lot."* Principals and educators showed awareness of the need to continuously improve skills for educators as a way to prepare them to enhance the teaching and learning of NS.

4.2.4.4 Role to be played by parents

Participants also felt there was a role to be played by parents in enhancing the teaching and learning of NS. PSB said, "*There are things that they cannot change because of the environment; they must play a role by supporting their learners. They* *must check their work on daily bases and motivate them. They must offer assistance when needed."* Similarly, SEA said, "*In order to help the learners, if the parent is unable to assist the learner, he or she can ask other parents who are literate"* and SEB also said, "*They must check learners' books, do follow ups and visit the school."* On the learners' side, SLB said, *"Parents must make sure that we get time for studying, and they must assist us in tasks given to school."* Participants were of the view that parents and guardians needed to take more interest in the learning of their children by monitoring and supporting their work as well as working closely with educators.

4.2.4.5 Role to be played by learners

Learners were also considered to have a role to play in enhancing the teaching and learning of NS. PSC *said "Learners should take their work seriously. No matter how serious we are if the learners themselves are not serious, learning will not produce results."* On the same issue, SEC said, *"Learners could come to school every day and do tasks on time, those who copy from other learners must stop. They should do their own reading and practice and not just rely on the teacher."* Learners also shared the same views as SLA said, "We need to s*tudy hard, read our books and ask our teachers where we do not understand. We must also be serious in doing research and not give excuses in class."* From the participants' views, it was shown that learners have a key role in enhancing the learning of NS by being actively involved in the learning of NS.

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4.2.4.6 Main findings on how the implementation of the Natural Science curriculum could be enhanced to promote scientific literacy in learners

The study also looked at how the NS curriculum can be enhanced to promote scientific literacy in learners. The participants indicated that school administrators and governors needs 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.

The participants also concurred that the DoE had a role to play to assist in the provision of specialist teachers as well as professional development and support of those in practice. Support was necessary to address content gap and pedagogical expertise. The DoE needed to put in place support mechanisms to inspect and support the teaching of NS to ensure compliance with requirements of the curriculum as set out in the CAPS curriculum documents.

It emerged from the study that parents were not supporting their learners to enhance teaching and learning of NS. All the interviewees agreed that parents had a role to play in supporting their children financially, materially and academically. Learners have a role to play too by working hard, doing school tasks, and limiting absenteeism.

4.3 DISCUSSION OF FINDINGS

The study sought to establish the implementation of the Natural Science curriculum in selected rural junior secondary schools from school principals, science teachers and science learners' perspectives. In this section, research findings are discussed in line with the research sub-questions that the study sought to answer. Discussion is done according to the thematic areas namely, educator preparedness for the teaching and learning of Natural Science, methods employed in the teaching and learning of Natural Science, challenges encountered in the teaching and learning of NS, and how the implementation of the NS curriculum be enhanced to promote scientific literacy in learners. Reference is made to both local and international literature.

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4.3.1 Educators preparedness in the teaching and learning of Natural Science

The study found that science educators were qualified teachers who were trained in other subjects but they were not specialist in NS. The educators were not specialist but they were available to teach NS. To be considered a subject specialist, the teacher should have thorough knowledge of content of the subject and this could be evidenced by possession of a basic junior degree in the area (Score Science Community Representing Education, 2011). The study's finding on teacher quality has a bearing on studies that have shown a positive correlation between a teacher's high academic qualifications and student achievement (Betts, Zau & Rice, 2003; Wayne & Younger, 2003). This shows that a teacher with higher academic and professional qualifications may contribute greatly to learners' academic achievement. One way for this is the understanding that such a teacher will have great content for the subject taught. Similarly, Angrist and Lavy (2001) are of the view that teachers should be trained in order to teach effectively and they should be specialists in the subject that they teach. In science teaching, it is not any teacher who can teach science. One should ideally have a degree in Science and an appropriate teaching qualification in order to be adequately prepared to teach Science at junior secondary school level.

According to Shulman (1992) teachers should have absolute understanding of the content of their subjects. The teacher, therefore, should be an expert in the subject that he or she teaches. Schmidt et al., (2007) say that in order for teachers to develop a thorough knowledge of subject content there is a need to include in the teacher training curriculum, rigorous and demanding subject matter courses. Such a curriculum would ensure teachers' adequate mastery of subject content. Where educators are not adequately prepared to teach any subject as specialists, the implementation of the curriculum is compromised. In order to give a solid foundation to Natural Science, three specific aims in Natural Sciences and Technology module are emphasised by the Department of Basic Education (2011b) Senior Phase and the researcher observed that while she was observing the lesson plans during data collection, however other teachers still have a challenge in understanding the policy document.

The study also established that educators' lack of preparedness in teaching NS resulted in problems with having the appropriate subject matter content. The researchers' view is that when the teacher is prepared, he or she should know science very well in order to implement it effectively. If the teacher lacks Science content or is not confident in teaching content, learning will be negatively affected. The researcher is of the view that when the teacher is prepared he or she must give the quality to learners. Lin et al (2010) underscore the importance of high quality teachers to ensure proper and meaningful teaching and learning.

The researcher is of the view that when the teacher is prepared to teach NS, he/she must know and understand the subject matter. Kleickmann et al (2013) state that pedagogical content knowledge (PCK) and content knowledge (CK) are key

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components of teacher competence that affect student progress. Content knowledge is referred to by Ball, Thames and Phelps (2008) as knowledge of the subject matter. In the teaching of Science this means how knowledgeable the teacher is in Science as a subject. In order for one to teach effectively, knowledge of the subject should be detailed. The teacher, therefore, should be an expert in the subject that he or she teaches.

Another finding was that teachers made use of policy documents to guide their teaching. The CAPS document specified the need to use the policy document in order 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 to the Department of Basic Education (2011c) 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 educator should be in a position to interpret the policy documents correctly in order to ensure effective implementation of the NS curriculum.

The study showed that educators did not get adequate district support from the Department officials for their improvement as science educators. There were general visits by district officials with very little of workshops for science teachers. The previous studies indicate that teachers are provided with assistance on a school-wide basis as well as in regular classrooms (Department of Education, 2005; Department of Basic Education (2011a). The DoE officials should play a larger role in promoting the teaching and learning of NS.The provincial curriculum year planner (2014) specifies the curriculum support that will be given to the schools. It mentions the priorities about teacher development and motivational programmes identify teacher content gaps, teacher support programmes, e-learning software and integration into subjects, functionality of curriculum structures, teacher workshops to support MTBBE

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4.3.2 Methods employed in the teaching and learning of Natural Science.

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, and 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 indicate that National Science Education Standards (National Research Council, 1996) claims 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 (2013) further underscores the importance of employing the appropriate teaching methods in science so as 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. Other teaching methods like Didacticism raises numerous constraints which involve rote learning, learning by note taking, and potential boredom as the approach limits student participation and reflection (Walkin, 2000). Similarly, Afonso and Gilbert (2010) advocate the use of pedagogical approaches that engage learners in critical thinking as well as application of scientific concepts. The researcher is of the view that using different approaches when teaching NS, it enhances the teaching and learning of science

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The principal participants also revealed that educators used different teaching and learning approaches in their classes, like investigations, learner centred approach, student involvement. The teachers used mostly the textbook, group work learner centred approach, investigations, experiments. The data showed that both the principals and teachers agreed about the approaches used. Teachers, however, experienced challenges in terms of experiments as they lacked resources in their schools. The approach they mostly used was the telling method. Many traditional lecturers continue to use the lecture as a means of teaching, especially when the subject is new to the majority of students or if the students are teacher dependent, anxious or disorganised as learners (Walkin, 2000). Muwanga-Zake (1998) also notes that that teacher training for science teachers is not good in South Africa and this result in science teachers who just rely on textbook notes and practical instructions in the teaching of science. Educators' reliance on the text book method or the telling method, potentially inhibited the learners' progress in learning NS.

Another key finding of the study in the teaching and learning methods employed in NS was that students participate in experiments despite the lack of resources. In support of this (Vygotsky 1985) highlighted that constructivism states that learning happens when learners construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences. Zhu, Ennis and Chen (2011) identified in their key features of constructivism that the learner is actively engaged in learning.

Prior studies suggests that teachers should identify practical applications of concepts, use practical experiences and applications to make connections between concepts and real world experiences in ways that enrich understanding of concepts, and show how knowledge of one set of concepts forms the foundation for learning about other concept (Gallagher, 2000). Gallagher continues by saying teachers can employ various methods to help students apply their knowledge such as conducting practical work, field trips, role play, and lastly one study reported that practical work improved students learning and understanding (Dawe, 2003).

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The study has highlighted another finding in the teaching and learning methods employed in NS. Data collected showed that group work was employed in the teaching of Natural Science. Vygotsky (1985) suggests that if in the course of study, one can be assisted by more skilled persons, such as peers and teachers, his/her support level is changed. Also, as his/her peers and teachers adjust their support towards his/her guidance needs, he/she may advance in terms of his/her zone of proximal development. In the face to face promotive interaction Vygotsky revealed that group members provide one another with feedback, teaching, helping, supporting, applauding and encouraging one another in order to reach group goals. The teachers in the study employed collaborative learning.

4.3.3 Challenges encountered in the teaching and learning of Natural Science.

Another key finding of the study was that laboratories and resources were not available. The participants concurred that resources for science are not available. Idiaghe (2004) observes that availability resources and academic productivity in learners are closely related. In a related study to draw this relationship, Idiaghe (2014) established that learners in schools with inadequate teaching and learning facilities performed lower compared to their counterparts in schools with adequate facilities. The Department of Basic Education (2011c) states that teachers should remember that it is more important for learners to have the experience of carrying out variety of investigations than to depend on the availability of equipment. In instances where equipment is limited, teachers should be encouraged to improvise. The same knowledge and skills can be developed using improvised equipment.

In showing the importance of appropriate resources in science teaching, Mudulia (2012) commented by saying that observation and experimentation are important approaches in science teaching and learning. Such approaches involve the learners actively in undertaking scientific projects and assist in developing their scientific literacy. Laboratories where experiments take place should be available in schools to ensure effective teaching and learning of science. 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 should be readily available.

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The study found that learners' deprived and rural background negatively affected the teaching and learning of NS. The data collected showed that the background really affected the teaching and learning of Natural Science in schools. International measures indicate that South African learners are performing poorly in science. For example of the 38 and 50 countries that participated in the trends in mathematics and science study (TIMSS) in 2001 and 2003, respectively, some of which are developing countries. South African learners came last in mathematics and science (Howie, 2003). Reddy (2004) who coordinate the study in South Africa, explained that there are multiple complex that contribute to learners poor performance. These include poverty, resources, learning cultures, infrastructure of school and low teacher qualification. The participants showed a lot of concern on the challenges of poverty that enhance the poor background that is affecting teaching and learning in rural schools.

The study further found that use of English as the language of learning and teaching negatively affected the implementation of the NS curriculum. Science is taught in English and English is a foreign language to all the learners in rural schools. Research has shown that use of foreign language in teaching and learning results in numerous problems for learners. Taylor and Prinsloo (2005) underscore the challenges of learning in a second language, which results in learners' failure to interpret the meaning of Mathematics and Science concepts.

It is clear from the above view that teaching science in a foreign language results in learners' problems of understanding concepts taught. Similarly, Ong and May (2004) observes that the problem is worsened if the science teachers are not proficient in English. Teaching Science in English to second language English speaking learners negatively affects the learners' performance (Ferreira, 2011). 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 rural learners learning science. Such learners do not grapple with science content only but also with a language that is foreign to them. Mokiwa and Msila (2013) further note that language has a strong effect on educational quality and rural and historically black schools in South Africa have the problem of the use of English as medium of instruction, which impacts on quality of education.

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Mutasa (2002) asserts that it is impossible for learners to understand and conceptualise content taught if the struggle with the language used in teaching the subject. The researchers agree with the foregoing statement above, because as a teacher it is difficult in the classroom when the learner does not understand English, as it is the tool for communication and according to Bell (2001) teaching and learning are vastly facilitated through the use of language.

Another finding highlighted by the study is that time allocation is not adequate to cover the subject content. The Department of Basic Education (2011c) states that:

> There seems to be an overlap between Geography and Natural Sciences, this might cause confusion for learners, when dealing with either of the subjects. The four knowledge areas are clearly listed; this is a good guide for the teacher since it assists the teacher in knowing what the expected outcomes.

In addition the Policy document mentioned above highlighted that in terms of time allocation the document cite 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 enough time will be available for such since the content is rather manageable.

The Department of Basic Education (2011c) also mentioned the general strength about NS such as a good flexible assessment guide is helpful for the teacher; the flexibility of the guide allows for the teacher to be creative in teaching the content and also because of the manageable time allows for individual student attention in schools where student numbers are small. The researcher is of the view that the time factor is a challenge according to the data collected and it raises concern as it is not easy to come with the solution because it depends on the Department of Education.

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4.3.4 How the implementation of the Natural Science curriculum could be enhanced to promote scientific literacy in learners.

From the study it emerged that the schools needed to make sure that necessary resources were available. The respondents indicated that there were roles that needed to be played by the schools. Three was need for laboratories to ensure proper teaching of NS. The National Science education standards (National Research Council [NRC] 1996) and other science education literature Bybee (2000); Lunetta (1998) emphasizes the importance of rethinking the role and practice of laboratory work in science teaching. The National Science Education Standards (National Research Council, NRC 1996) also indicates the importance of engaging learners in describing and in using observational evidence and current scientific knowledge to construct and evaluate alternative explanations" based on evidence and logical argument". Orji (2006) found strong relationship between teachers' know-how and students' achievement. He further found that library materials and science laboratory equipment are positively related to the performance of students. Orji continued by saying science instruction/teaching is more effective when laboratory materials are available and when these are well used. The researcher agrees with Orji, since she is a natural science teacher, resources are very important and they enhance the performance of learners.

Teachers need support from the department in terms of school visits and professional development. The Department of Education (2005) on Teacher and support staff working together standard guidelines, teachers and other service related professionals' support staff provide assistance on a school-wide basis as well as in regular classrooms. They are responsible for carrying out a variety of duties which may be specific to individuals or address the needs of groups of students.

DoE (2005) further continue by noting that the success of the support staff role depends greatly on the level of cooperation and collaboration that exists among the educational partners. School principals must ensure that all school staff has a clear understanding of where support staff services fit into their school plan. Support staff must have a clear understanding of their roles and how the school addresses the needs of all students. Teachers are responsible for the overall direction, education and management of programming, evaluating, reporting, and designing interventions for all students within the classroom DoE (2005). Therefore, any and all activities that support staffs are assigned to carry out must be directed and monitored by a teacher or other teaching professional.

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In terms of the professional development, if the educator is considered as a member of a cooperating team, teaching experience might not be a necessary prerequisite for all on entering the profession. However, most countries seem to require that all teacher educators have at least a teaching qualification and basic pedagogical skills, entailing a full programme of initial teacher education and teaching practice (Caena, 2012).

Since there is no initial training for teacher educators and only limited induction opportunities for teacher educators to reflect and to develop their professional qualities throughout their careers are extremely important. These learning opportunities should respond to individual professional needs, but also prepare them for new developments in (teacher) learning, (teacher) education, the teaching profession and society (Smith, 2007). The researcher supports the literature because professional development boosts the teachers' confidence and support, motivates the teachers to work very hard.

Team collaboration among teachers in different schools was another finding that emerged from the study. Data collected revealed how the implementation of the Natural Science curriculum be enhanced to promote scientific literacy in learners, that the teachers are interested in working as group of teachers to promote scientific literacy in learners. They continue by saying that there are experts in science that can help to close the content gap and motivate them to work on common tasks. A number of recent studies indicate that the benefits of collaborative learning include the development of interpersonal skills (Jun & Pow, 2011), active involvement in the teaching and learning process (La-fifi & Touil, 2010), enhancement of critical thinking (Cheong, Bruno, & Cheong, 2012) and learning conflict resolution and taking ownership of the project/results (Johnson & Johnson, 1986). The researcher is of the view that working as teams enhance teaching and learning of NS and the researcher agree more with the studies above.

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Carnegie (1984) states that, in a collaborative culture, members of the school community work together effectively and is guided by a common purpose. All members of the community—teachers administrators, students and their families—share a common vision of what the school should be like. Together they set goals that lead them toward this vision. The researcher is supporting the views of researchers above, working as a team makes the progress easy because there is an opportunity of asking questions, clarity when you do not understand, and you get more help from the experts. Working as teams also promote results because all the teachers work according to the expected pace and they share resources and exchange phone numbers so that when one is experiencing challenges alone it is easy to consult the expert.

4.4 SUMMARY

This chapter presented, interpreted, analysed and discussed the findings. Presentation and discussion were done thematically, with themes drawn from the sub-research question of the study. Discussion of finding was done by referring to similar findings in literature. The next chapter gives summary of the findings, makes recommendations and concludes the study.

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CHAPTER 5

SUMMARY OF THE FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

5.1 INTRODUCTION

This chapter summarises the findings of the study according to the sub-research questions of the study and makes recommendations based on the research findings. It also gives the conclusion to the study and the contributions it has made. In addition, the chapter also gives direction and suggestions into the future studies that could be founded upon this study.

5.2 RESTATING THE RESEARCH PROBLEM

The study was carried out because of the poor performance of students in science subjects like Physical science at matric level. Results of the South African National study in mathematics and science revealed that Eastern Cape Province is among the lowest performers and this is a cause for concern. In addition, if Natural Science is not taught properly at junior level, learners will struggle with science subjects at senior school level. The intention was to establish how the Natural science curriculum is implemented in rural junior schools.

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5.3 SUMMARY OF FINDINGS

This section gives a summary of the findings on each of the sub-research questions that the study sought to answer.

5.3.1 Sub-research question 1

It was established from the study that educators were available and qualified to teach but they were not NS specialists as none of them possessed a junior degree in science or science education. Whilst educators attended workshops related to the new CAPS curriculum, there were no coordinated and regular professional development programmes for science teachers, in terms of enriching science content or pedagogical expertise. Despite many years of experience, none of the educators had professionally developed themselves by acquiring academic or professional degrees in science or science education. Educators showed that they were able to interpret the new CAPS NS curriculum because of workshops attended and curriculum documents available. Concerns were still raised on challenges regarding interpreting the NS CAPS curriculum document, which educators stated that they still required assistance in. There were, however, some topics in the new curriculum that they were not confident in teaching. District officials visited schools for general routine visits for supervision but there few workshops targeting science educators.

5.3.2 Sub-research question 2

It was established from the participants' views that educators were aware of the different teaching and learning approaches. Educators also attempted to involve learners in the learning of different concepts by using learner centred approaches and this was confirmed by the learners themselves. However, because of lack of resources, educators did not always involve learners in learning and would resort to the telling method. Approaches such as group work and experiments were employed. Educators also attempted to link NS concepts to what the learners already knew.

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5.3.3 Sub-research question 3

It emerged from the participants' responses that there were challenges of resources in schools and this impacted negatively on the teaching and learning of science. The realisation that schools did not have laboratories, science equipment and adequate textbooks points to serious problems in effective science curriculum implementation. Another key finding of this study was that learners' background and the use of English as LoLT also negatively affected the teaching and learning of science. Lack of parental support was also another challenge. It also emerged from the study that time allocation for NS was not enough to cater for all the theoretical and practical work involved. Some challenges related to learner absenteeism as well as lack of cooperation with teachers.

5.3.4 Sub-research question 4

The DoE has a role to play in the provision of specialist teachers as well as professional development and support of those in practice. Support was necessary to address content gap and pedagogical expertise. The DoE needed to put in place support mechanisms to inspect the teaching of NS to ensure compliance with requirements of the curriculum as set out in the CAPS curriculum documents. It emerged from the study that parents were not supporting their learners to enhance teaching and learning of NS. All the interviewees agreed that parents had a role to play in supporting their children financially, materially and academically. All the participants agreed that learners' role was to learn more, work hard, do school tasks, and minimise absenteeism from school.

It further emerged from the study that for Natural Science curriculum to be enhanced to promote scientific literacy in learners, all the stake holders involved must play a role. The school must make sure that resources are available; the DoE must develop teachers in Natural Science. Educators' role was seen as that of collaborating with NS experts in their circuits to develop each other. Parents should support their learners in their school work closely with educators to monitor and support learning.

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5.4 CONCLUSION

The purpose of the study was to establish how Natural Science curriculum was implemented in selected rural junior secondary schools in one education district of the Eastern Cape Province of South Africa. The study followed an interpretivist research paradigm and employed a qualitative approach to seek in depth understanding of the issue from the point of view of participants. A case study design was utilised as it allowed the researcher to gain insights through in depth understanding of how Natural Science teachers and learners saw and experienced teaching and learning of the subject. Purposive sampling was used to select one school principal, one science teacher and six learners in each of the three selected rural schools. Data were collected using individual interviews with teachers and principals, focus group interviews with learners and observation of science lessons. To analyse data, qualitative content analysis method was used. Audio taped interviews were transcribed and data were coded, sorted and categorised to ensure thematic analysis.

The study found that educators were available and qualified to teach but they were not NS specialists as none of the teachers possessed a junior degree in science or science education. Whilst educators attended workshops related to the new CAPS curriculum, these were not coordinated and regular professional development programmes for science teachers, and offered very little in terms of enriching science content or pedagogical expertise. None of the educators despite many years of experience had professionally developed themselves by acquiring academic or professional degrees in science or science education. Educators showed that they were able to interpret the new CAPS NS curriculum because of workshops attended and curriculum documents available.

It was established from the participants' views that educators were aware of the different teaching and learning approaches. Educators also attempted to involve learners in the learning of different concepts by using learner centred approaches and this was confirmed by the learners themselves. However, because of lack of resources, educators did not always involve learners in learner-centred learning and would resort to the telling method. Approaches such as group work and experiments were employed.

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The study also found that there were challenges of resources in schools and this impacted negatively on the teaching and learning of science. There was lack of basic infrastructure, science equipment and adequate textbooks. Learners' background and the use of English as language of learning and teaching also negatively affected the teaching and learning of science. Lack of parental support was also another challenge. It also emerged from the study that time allocation for Natural Science was not enough to cater for all the theoretical and practical work involved.

It also emerged from the study that, for Natural Science curriculum to be enhanced to promote scientific literacy in learners, all the stakeholders involved must play a role for instance to ensure provision of teachers and resources as well support for teaching and learning of science. It was also proposed by the participants that teachers must play a role too by collaborating with NS experts in their circuits to develop each other. Parents should support their learners in their school work, and visit schools for learner progress. Learners should learn more, work very hard and do school tasks.

5.5 CONTRIBUTION OF THE STUDY

The study has contributed to the teaching and learning of science and many stakeholders will benefit. The teachers as the curriculum implementers will benefit more because they will be able to reflect on their current approaches they used with the hope to improve them. Teaching and learning of science will be promoted because all the stakeholders will prioritise in schools such as looking into the availability of NS resources. The study promotes team collaboration may sensitise the stakeholders to work together to promote the teaching and learning of NS. Teachers will go further in developing themselves to be the specialist and experts in the subject; they will be able to learn computer skills so that when they encounter challenges in the content gap, they will look for it in the internet.

5.6 RECOMMENDATIONS

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Based on the findings of this study, the researcher advances the following recommendations to NS stakeholders:

- The Department of Basic education should ensure that educators appointed to teach NS in schools are trained educators who are science specialists.
- Because of the irregular and uncoordinated nature of the professional development support, the study recommends that the Department of Basic Education should increase the number of professional development workshops in NS teaching and coordinate them more closely.
- The Department of Basic Education should 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.
- School staff exchange programmes should be encouraged so that teachers learn best practices in NS teaching and learning from other schools.
- Basic infrastructure such as science laboratories and running water should be made available in all rural schools.

- Basic resources such as textbooks and science apparatus should also be made available in schools to ensure meaningful teaching and learning of Science.
- Parents and guardians should play a more supportive role on the learning of children in schools.

5.7 SUGGESTIONS FOR FURTHER STUDY

The researcher acknowledges that the study was conducted on a small scale comprising one small district and in three selected rural schools. Future studies may contribute by conducting a similar investigation again on a larger scope, and even taking a comparative dimension between districts and among schools. Future research may narrow the focus of the study to a single aspect like time constraints in the implementation of the NS curriculum, in order to benefit from a narrowed focus.to be issues that inhibit the teaching and learning of NS e.g. time allocation which is basically depending on the Department of Education. They will also consider environmental factors which affect the learners in the classroom and end up not cooperating in the class.

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5.8 ACHIEVEMENT OF RESEARCH OBJECTIVES

The study intended to achieve the following objectives:

- To ascertain the preparedness of teachers in the teaching and learning of Natural Science.
- To establish the teaching and learning methods employed in the teaching and learning of Natural Science
- To identify challenges encountered in the teaching and learning of Natural Science.
- To suggest how the teaching and learning of the Natural Science curriculum can be enhanced to promote scientific literacy in learners.

From the data collected through observations, individual semi-structured interviews, focus group interviews, objectives were achieved. The study proposed the measures that could be employed to promote scientific literacy in learners. Views of the participants were captured on teacher preparedness in the teaching and learning of NS, methods employed by teachers in teaching and learning of NS, challenges encountered in the teaching and learning of NS as well as suggestions on how to enhance the implementation of the NS curriculum.

5.9 CONCLUDING REMARKS

The study aimed at establishing the implementation of the Natural Science curriculum in rural junior secondary schools. The study also aimed at making the teachers aware of the different teaching approaches they could use to assist in the effectiveness of the curriculum. The study identified the challenges that inhibit the teaching and learning of NS in schools. The study also proposed measures to be taken to address the challenges and to promote scientific literacy in learners. Recommendations were proffered where in-service training and professional development and team collaboration were highly recommended.

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APPENDIX A: PRINCIPALS' INTERVIEW SCHEDULE

INDIVIDUAL INTERVIEWS WITH SCHOOL PRINCIPALS

STUDY GUIDING RESEARCH QUESTIONS	INTERVIEW QUESTIONS
How are the teachers prepared in the teaching and learning of Natural Science?	• 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?
What are the methods employed in the teaching and learning on Natural Science?	• In your supervision of Science teachers, do you think they are aware of different approaches in teaching Science? If you could give examples of what you have observed. • What are some of the teaching approaches that you have observed Science teachers employing? • Do you think the teaching approaches employed are useful in enhancing student learning of science?
What are the challenges encountered in the teaching and learning of Natural Science?	• 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 Science 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?
How can the implementation of the Natural Science curriculum be enhanced to promote scientific literacy in learners?	• 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 do you think could be done by parents to enhance the teaching and learning of NS in the school?

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APPENDIX B: EDUCATORS' INTERVIEW SCHEDULE
INDIVIDUAL INTERVIEWS WITH SCIENCE TEACHERS

STUDY GUIDING RESEARCH QUESTIONS	INTERVIEW QUESTIONS
How are the teachers prepared in the teaching and learning of Natural Science?	Training in Science teaching • Tell me about yourself as a Science teacher, your education, training and experience? • Do you see yourself adequately prepared to teach NS? Professional development and support • What professional development courses and workshops in science teaching have you attended? • If you have attended any, who offered these and how helpful were these in enhancing your science teaching? • Does the Department of Education support your science teaching? If so, how does it support you? Science teaching policies and interpretation • 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? NS Content • Are you familiar with the content that is supposed to be taught in NS at senior phase level? What are some of the common topics? • Where do you derive the content for your teaching of the different topics? • Can you rate yourself a science expert? Why?
What are the teaching and learning methods employed in the teaching of Natural Science?	Pedagogical issues in science teaching • 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?

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	• 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.
What are the challenges encountered in the teaching and learning of Natural Science?	<u>Resources in science teaching and learning</u> • Where do you conduct science lessons? • Is there a purposefully built science laboratory in the schools? • Do you have adequate apparatus and other equipment for carrying out of experiments and practical work in investigations? • Do you have adequate textbooks and reference materials in teaching and learning of science? • In your view, is time allocated to the teaching of Natural Science adequate? <u>Students' background and science teaching and learning</u> • How does the issue of English as a language of instruction affect the teaching and learning of NS? • Do learners show interest in learning science? • Do learners get support from home in their learning of science? Do learners' social and cultural backgrounds in a way affect their learning of science? • What other challenges do you encounter in the teaching of NS? • What other challenges do learners encounter in the learning of NS? • What measures are you taking to address the challenges in the teaching and learning of NS?
How can the teaching and learning of Natural Science be enhanced to promote scientific literacy in learners?	• 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

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	school? • What do you think could be done by teachers to enhance the teaching and learning of NS in the school? • What do you think could be done by parents to enhance the teaching and learning of NS in the school? • What do you think could be done by learners to enhance the learning of NS in the school?

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APPENDIX C: LEARNERS' INTERVIEW SCHEDULE

INDIVIDUAL INTERVIEWS WITH SCIENCE LEARNERS

STUDY GUIDING RESEARCH QUESTIONS	INTERVIEW QUESTIONS
How are the teachers prepared in the teaching and learning of Natural Science?	<u>NS Content</u> • What can you say about your Natural Science teacher's knowledge of the subject? • Does the teacher show confidence and knowledge in teaching the subject. • Can he or she explain well what he or she will be teaching? • Can he or she answer all the questions asked by learners about what he or she will be teaching? • Can you rate your teacher as a science expert? Why?
What are the teaching and learning methods employed in the teaching of Natural Science?	<u>Pedagogical issues in science teaching</u> • Do you understand when your teacher is teaching Natural Science? • Do you participate when experiments are conducted in the classroom? Explain further how you participate? • When you don't understand do you ask questions for clarity from the teacher? • Do you work as groups in the classroom e.g. planning investigations or preparing group debates or presentations? If yes how is it done? • Do you work on science related projects? If so give examples. • Do you work in small groups during Natural Science lessons? • Does the teacher link new concepts to what you already know? If so, give examples of some of the concepts.
What are the challenges encountered in the teaching and learning of Natural Science?	<u>Resources in science teaching and learning</u> • Where do you conduct science lessons? • Is there a purposefully built science laboratory in the schools? • Do you have adequate apparatus and other equipment for the carrying out of

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	experiments and practical work in in science? • Do you have adequate textbooks and reference materials in learning of science? • In your view, is time allocated teaching of Natural Science adequate? <u>Students' background and science teaching and learning</u> • How does the issue of English as a language of instruction affect your learning of NS? • Are you interested in learning NS? Why? • Do you get any support from home in your learning of science? If so, what kind or form of support do you get? • What other challenges do you encounter in learning of NS? • What, in your view, could be done to address the challenges in your learning of NS?
How can the teaching and learning of Natural Science be enhanced to promote scientific literacy in learners?	• What do you think could be done by the school administration to enhance teaching and learning of NS in the school? • What do you think could be done by teachers to enhance the teaching and learning of NS in the school? • What do you think could be done by parents to enhance the teaching and learning of NS in the school? • What do you think could be done by learners themselves to enhance the learning of NS in the school?

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APPENDIX D: ISIXHOSA TRANSLATED LEARNERS' INTERVIEW SCHEDULE

UCWANGCISO LO DLIWANO NDLEBE LWABANTWANA

UDLIWANO NDLEBE NGOKWA MAQELA KWEZE NZULULWAZI

ISIKHOKELO SEMIBUZO	IMIBUZO NGO DLIWANO NDLEBE
Ingaba ootishala bakulungele kangakanani ukufundisa nokufundwa kwesifundo se nzululwazi?	<u>I contenti ngeze nzululwazi</u> • Ungathini ngolwazi lwe tishala yakho kwesi sifundo se nzulu-lwazi? • Ingaba u Tishala uyakubonakalisa ukuqiniseka nolwazi malunga nesisifundo? • Ingaba uyakwazi ukucacisa kakuhle azakufundisa? • Ingaba uyakwazi ukuphendula imibuzo ebuzwa ngabafundi ngazakufundisa? • Ungambeka kwinqanaba lenkcuba-buchopho kwizifundo zenzululwazi? [illegible]cisa ngoba? •
Zeziphi i methodi ezisetyenzswayo ekufundiseni naseku fundweni kwesi fundo se nzululwazi?	<u>Ulwazi oluphangaleleyo lokufundisa ezenzululwazi</u> Zeziphi i methodi ezisetyenzswayo ekufundiseni naseku fundweni kwesi fundo se nzululwazi? • Uyeva xa uTishala wakho efundisa esisifundo? • Niyayithatha inxaxheba xa kusenziwa umfanekiso ngqo ngesifundo? • Xaningeva niyayibuza imibuzo ku Tishala ukuze nicacelwe? • Niyasebenza ngamaqela kwi gumbi lokufundela umzekelo: ukuplana ezophando, nokuxoxa ngesifundo? Ukuba kunjalo nenza kanjani? • Niyasebenza kwi projekthi zenzululwazi? Ukuba kunjalo nisebenza kanjani? • Niyasebenza ngokwamaqela amancinci kwesisifundo? • Ingaba u Tishala uyalusebenzisa ulwazi olutsha kunye nolo sele unalo? Ukuba kunjalo nika imizekelo?
Zeziphi ngxaki ezifumanekayo ekufundisweni nasekufundeni eze nzululwazi?	<u>Izixhobo malunga nokufundiswa nokufunda eze nzululwazi</u> • Niziqhubela phi izifundo ze nzululwazi?

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	• Lingaba likhona igumbi elinezixhobo zodwa zokufundisa ezenzululwazi? • Ingaba ninazo na izixhobo ezoneleyo ukuqhuba imifanekiso ngqo malunga nesisifundo, nokwenza imisebenzi yezandla xa nisenza uphando kwesisifundo? • Ninazo na incwadi ezisemgangatweni ezoneleyo, kunye ne nezinye izixhobo ezinokuninceda ekufundeni esisifundo se nzululwazi? • Ngokwe mbono yakho ingaba elixesha lokufundisa esisifundo lonele na? <u>Ibekigrawundi yabafundi malunga nokufundiswa noku fundwa kweze nzululwazi</u> • Ukufundiswa nge singesi ingaba kuya sichaphazela na esisifundo se nzululwazi? • Ingaba unawo na umdla kwesisifundo se nzululwazi? Nika isizathu? • Uyalufumana na uncedo okanye ukuncediswa ekhaya kwesisifundo? Ukuba kunjalo luncedo olunjani olufumanayo? Zeziphi ezinye ingxaki ozifumanayo kwesi sifundo? • Ngoko mbono wakho zeziphi izinto ezinokwenziwa uku khawulelana nezingxaki uzifumana kwesisifundo se nzululwazi?
Ingaba ukufundiswa noku funda esisifundo senzululwazi kunganyuswa kanjani ukuphuhlisa ubuchwephesha kwesisifundo?	• Yintoni engenziwa nga ba Phathi besikolo ukunyusa izinga lokufundiswa kwesisi fundo? • Yintoni ocinga ukuba ingenziwa ngo Tishala ukunyusa ukufundiswa nokufundwa kweze nzululwazi kwe sisikolo? • Abazali bona bangenza kanjani ukunyusa ukufundiswa nokufundwa kwesisifundo kwesisikolo? • Abafundi bona bangadlala eyiphi indima ukunyusa izinga lokufundwa kwesisifundo se nzululwazi kwesi sikolo?

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APPENDIX E: LESSON OBSERVATION GUIDE

Date: ____

Time: ____

Duration of lesson: _________________________________

Grade: ____

Topic: ____

Learning Outcomes:

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Lesson Introduction

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Teacher Activities

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Learners Activities

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Teaching and Learning Materials

Teacher's content accuracy and confidence

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Formative and Summative Assessment

Achievement of learning outcomes

APPENDIX F: INFORMED CONSENT FORM FOR EDUCATORS AND PRINCIPALS

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Ethics Research Confidentiality and Informed Consent Form

The University of Fort Hare, Faculty of Education is asking educators and learners from your school to answer some questions, which we hope will benefit your school and possibly other schools in the future.

I am a student at the University of Fort Hare and I am conducting research regarding the implementation of Natural science curriculum in selected junior secondary schools. I am interested in finding out more about how Natural Science curriculum is implemented in junior secondary schools. I am carrying out this research to help seek find out how Natural science is taught and learnt in schools and suggest areas for improvement.

Please understand that you are not being forced to take part in this study and the choice whether to participate or notis yours alone. However, we would really appreciate it if you do share your thoughts with us. If you choose not take part in answering these questions, you will not be affected in any way. If you agree to participate, you may stop me at any time and tell me that you don't want to go on with the interview. If you do this there will also be no penalties and you will NOT be prejudiced in ANY way. Confidentiality will be observed professionally.

I will not be recording your name anywhere on the questionnaire and no one will be able to link you to the answers you give. Only the researchers will have access to the unlinked information. The information will remain confidential and there will be no "come-backs" from the answers you give.

The interview will last around 20 minutes. I will be asking you a questions and ask that you are as open and honest as possible in answering these questions. Some questions may be of a personal and/or sensitive nature. I will be asking some questions that you may not have thought about before, and which also involve thinking about the past or the future. We know that you cannot be absolutely certain about the answers to these questions but we ask that you try to think about these questions. When it comes to answering questions there are no right and wrong answers. When we ask questions about the future we are not interested in what you think the best thing would be to do, but what you think would actually happen. (*adapt for individual circumstances*)

If possible, our organisation would like to come back to this area once we have completed our study to inform you and your community of what the results are and discuss our findings and proposals around the research and what this means for people in this area.

INFORMED CONSENT

I hereby agree to participate in research regarding the implementation of NS curriculum in selected rural junior secondary schools. I understand that I am participating freely and without being forced in any way to do so. I also understand that I can stop this interview at any point should I not want to continueand that this decision will not in any way affect me negatively.

I understand that this is a research project whose purpose is not necessarily to benefit me personally.

I have received the telephone number of a person to contact should I need to speak about any issues which may arise in this interview.

I understand that this consent form will not be linked to the questionnaire, and that my answers will remain confidential.

I understand that if at all possible, feedback will be given to my school on the results of the completed research.

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....
Signature of participant **Date:.......................**

I hereby agree to the tape recording of my participation in the study

....
Signature of participant **Date:**.......................

APPENDIX G: INFORMED CONSENT FORM FOR PARENTS

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PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM FOR USE BY PARENTS/LEGAL GUARDIANS

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TITLE OF THE RESEARCH PROJECT:

IMPLEMENTATION OF THE NATURAL SCIENCE CURRICULUM IN SELECTED RURAL JUNIOR SECONDARY SCHOOLS IN COFIMVABA EDUCATION DISTRICT

REFERENCE NUMBER:

PRINCIPAL INVESTIGATOR: Mtsi Nomxolisi

ADDRESS:CWECWENI J.S.S
Box 80
Ngcobo
5050
CONTACT NUMBER: 071 97 89 333

Your child is being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study staff or doctor any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how your child could be involved. Also, your child's participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you or your child negatively in any way whatsoever. You are also free to withdraw him/her from the study at any point, even if you do initially agree to let him/her take part.

This study has been approved by the **University Research Ethics Committee at the University of Fort Hare** and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

The study seeks to look into the teaching and learning of Natural Science in selected rural secondary schools in Cofimvaba Education district.

Why has your child been invited to participate?

Your child has been invited to participate in the study simply because he or she is studying Natural Science and will be expected to answer some questions around the teaching and learning of Natural Science.

What will your responsibilities be?

As parent to the child, you need to give permission that your child will participate in the study.

Will your child benefit from taking part in this research?

There are no personal benefits that the child will gain from participating in the study.

Are there any risks involved in your child taking part in this research?

There are risks involved in your child's participation in the study.

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If you do not agree to allow your child to take part, what alternatives does your child have?

If you feel you do not like your child to participate in the study, feel free to indicate that and the child will not be forced to participate without your consent.

What will happen in the unlikely event of your child getting injured in any way, as a direct result of taking part in this research study?

There is no possibility of the child getting injured while participating in this study.

Will you or your child be paid to take part in this study and are there any costs involved?

You or your child will not be paid to take part in the study. There will be no costs involved for you if your child does take part.

Is there anything else that you should know or do?

You can contact the Chairperson of the University Research Ethics Committee if you have any concerns or complaints that have not been adequately addressed by your child's study doctor.

You will receive a copy of this information and consent form for your own records.

Assent: Children with an age of 7 and above must give assent to participate in research

Declaration by parent/legal guardian

By signing below, I *(name of parent/legal guardian)* ………………………………………… agree to allow my child (name of child) …………………………………… who is ………. years old, to take part in a research study entitled *(insert title of study)*

I declare that:

- I have read or had read to me this information and consent form and that it is written in a language with which I am fluent and comfortable.
- If my child is older then 7 years, he/she must agree to take part in the study and his/her ASSENT must be recorded on this form.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to let my child take part.
- I may choose to withdraw my child from the study at any time and my child will not be penalised or prejudiced in any way.
- My child may be asked to leave the study before it has finished if the study doctor or researcher feels it is in my child's best interests, or if my child do not follow the study plan as agreed to.

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Signed at (*place*) ………………………………………… on (*date*) ………………………………

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

Signature of parent/legal guardian **Signature of witness**

Declaration by investigator

I *(name)* ……………………………………………………… declare that:

- I explained the information in this document to …………………………………….
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understand all aspects of the research, as discussed above
- I did/did not use a interpreter (i*f a interpreter is used, then the interpreter must sign the declaration below).*

Signed at (*place*) ………………………………………… on (*date*) ………………………

………………………………………………………………

Signature of investigator

Declaration by interpreter (Only complete if applicable)

I *(name)* ……………………………………………………… declare that:

- I assisted the investigator (*name*) ……………………………………… to explain the information in this document to (*name of parent/legal guardian*) ……………………………… using the language medium of Afrikaans/Xhosa.
- We encouraged him/her to ask questions and took adequate time to answer them.
- I conveyed a factually correct version of what was related to me.
- I am satisfied that the parent/legal guardian fully understands the content of this informed consent document and has had all his/her questions satisfactorily answered.

Signed at (*place*) …………………………………………… on (*date*) ……………………………

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

Signature of interpreter **Signature of witness**

APPENDIX H: DEPARTMENT OF EDUCATION PERMISSION LETTER

Province of the
EASTERN CAPE
EDUCATION

STRATEGIC PLANNING POLICY RESEARCH AND SECRETARIAT SERVICES
Steve Vukile Tshwete Complex • Zone 6 • Zwelitsha • Eastern 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@edu.ecprov.gov.za Date: 22 October 2014

Ms. Nomxolisi Mtsi

P.O. Box 2508

Dutywa

5000

Dear Ms. Mtsi

PERMISSION TO UNDERTAKE A MASTERS THESIS: IMPLEMENTATION OF THE NATURAL SCIENCE CURRICULUM IN SELECTED RURAL JUNIOR SECONDARY SCHOOLS IN COFIMVABA EDUCATION DISTRICT

1. Thank you for your application to cond

2. Your application to conduct the above mentioned research at selected schoolS under the jurisdiction of Cofimvaba District of the Eastern Cape Department of Education (ECDoE) is hereby approved on condition that:

    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 approval 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, as educators' programmes should not be interrupted;

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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. the research may not be conducted during the fourth school term, except in cases where a special well motivated request is received;

h. your research will be limited to those schools or 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;

i. 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.

j. you present the findings to the Research Committee and/or Senior Management of the Department when and/or where necessary.

k. you are requested to provide the above to the Chief Director: Strategic Management Monitoring and Evaluation upon completion of your research.

l. you comply with all the requirements as completed in the Terms and Conditions to conduct Research in the ECDoE document duly completed by you.

m. you comply with your ethical undertaking (commitment form).

n. 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 Kanjana on the numbers indicated in the letterhead or email nelisakanjana@gmail.com should you need any assistance.

NY KANJANA
DIRECTOR: STRATEGIC PLANNING POLICY RESEARCH & SECRETARIAT SERVICES

FOR SUPERINTENDENT-GENERAL: EDUCATION

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APPENDIX I: LETTER REQUESTING UNIVERSITY ETHICAL CLEARANCE

Mtsi Nomxolisi
Box 2508
Dutwa
5000

July 8, 2014

University Research Ethics Committee
University of Fort Hare

APPLICATION FOR ETHICAL CLEARANCE

I hereby apply for ethical clearance to conduct research towards the award of Masters of Education on the topic “Implementation of the Natural Science Curriculum in selected rural junior secondary schools on Cofimvaba Education District”. I am a Master of Education student in the Faculty of Education, East London campus.

I will like to collect data from principals, educators and learners in selected rural junior secondary schools in Cofimvaba Education District. The instruments of data collection include focus group discussions and in-depth interviews.

Enclosed are the necessary ethical clearance forms duly filled, signed and endorsed by me and the relevant faculty authorities, curriculum vitae, budget and proposal.

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I look forward to the ethical clearance so that I can proceed with my data collection exercise.

Sincerely yours,

Nomxolisi Mtsi

APPENDIX J: UNIVERSITY ETHICAL CLEARANCE CERTIFICATE

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ETHICAL CLEARANCE CERTIFICATE
REC-270710-028-RA Level 01

Certificate Reference Number:	MAP021SMTS01
Project title:	Implementation of the Natural Science Curriculum in selected rural junior secondary schools on Cofimvaba Education District
Nature of Project:	Masters
Principal Researcher:	Nomxolisi Mtsi
Supervisor:	Pro[illegible]hosa
Co-supervisor:	

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 above-mentioned 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.

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Please note that the UREC must be informed immediately of

- Any material change 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.

The UREC retains the right to

- Withdraw or amend this Ethical Clearance Certificate if
    - Any unethical principal or practices are revealed or suspected
    - Relevant information has been withheld or misrepresented
    - 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

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The Ethics Committee wished you well in your research.

Yours sincerely

Professor Gideon de Wet
Dean of Research

23 September 2014

APPENDIX K: LETTER OF EDITING AND PROOF-READING

SOL PLAATJE
UNIVERSITY

Department of Education
Private Bag X 5008, Kimberley, 8300
North Campus, Chapel Street, Kimberley
E-mail: [illegible]
Website: www.spu.ac.za
Tel: 27873105390
Cell: 0945282087
9 February 2015

TO WHOM IT MAY CONCERN

I hereby confirm that I have proof read and edited the following Masters dissertation using Windows 'Tracking' System to reflect my comments and make suggested corrections for the student to action:

Implementation Of The Natural Science Curriculum In Selected Rural Junior Secondary Schools In Cofimvaba Education District By Nomxolisi Mtsi, Submitted In Fulfilment of the Requirements for the Degree of Master Of Education, Faculty of Education, University of Fort Hare.

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Although the greatest care was taken with the editing of this document, the final responsibility for the product rests with the author.

Sincerely

09. 02. 2015

SIGNATURE DATE

APPENDIX L: PROGRAMME FOR INTERVIEWS AND OBSERVATION

PROGRAMME FOR INTERVIEWS AND OBSERVATION

DATE	ACTIVITY	TARGET	TIME
31-10-2014	One to one audio-recorded interview	Principal School A	40 minutes
31-10-2014	One to one audio-recorded interview	Science Educator School A	30 minutes
31-10-2014	Focus group audio-taped interview	Six Grade eight learners in School A	40 minutes
31-10-2014	Lesson observation of Science lesson	School A	1 hour
03-11-2014	One to one audio-recorded interview	Principal School B	30 minutes
03-11-2014	One to one audio-recorded interview	Science Educator School B	40 minutes
03-11-2914	Focus group audio-taped interview	Six Grade eight learners in School B	40 minutes
03-11-2014	Lesson observation of Science lesson	School B	1 hour
07-11-2014	One to one audio-recorded interview	Principal School C	35 minutes
07-11-2014	One to one audio-recorded interview	Science Educator School C	35 minutes
07-11-2014	Focus group audio-taped interview	Six Grade eight learners in School C	35 minutes
07-11-2014	Lesson observation of Science lesson	School C	1 hour

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