HOW EDUCATORS INTERPRET AND INTEGRATE THE ASSESSMENT STANDARDS WHEN CONDUCTING SCIENTIFIC INVESTIGATIONS IN THE INTERMEDIATE PHASE

by

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DEDICATION

This dissertation is dedicated to:

Molatelo Johannes, my late father

who passed on while I was still studying

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Abstract

The shortage of scientists in South Africa today can be attributed to poor teacher development especially in Natural Sciences. Educator interpretation and integration of assessment standards when conducting scientific investigations in Natural Sciences in the Intermediate Phase, is what this study sought to explore.

The National Curriculum Statement (NCS) policy outlines the seven roles to be fulfilled by educators in the Norms and Standards for educators. However, this investigation focused mainly on the two roles for educators:

- Interpreters and designers of learning programmes and materials (LO 1: Scientific Investigations)
- Scholars, researchers and lifelong learners (DoE, 2002:3)

The five schools sampled are from Mankweng area, situated in the Capricorn district in Limpopo province of South Africa. The data was qualitatively collected using the interviews, observations and document analysis as strategies. Before the investigation starts, all participants were told that the investigation was on how they (educators) design (plan), present and assess learners when conducting Learning Outcome 1: Scientific Investigations and how they integrate the assessment standards. The observation and interview schedules were clarified during the meeting.

The study revealed that most educators do not know different types of scientific investigations, their lessons designed showed little understanding of LO 1: Scientific Investigations and the integration of assessment standards which are: 1. *Planning investigation* 2. *Conducting scientific investigation and collecting data*. 3. *Evaluating data and communicate findings.* Data analysed revealed that most educators have little understanding and follow a direct teaching style, and thus Construct Scientific Knowledge (LO 2). Only one educator of the 13 observed and interviewed was able to integrate assessment standards 1 and 2. There is a relationship between the level of qualification and better understanding of NCS implementation because the educator above is a scholar, researcher and lifelong learner.

I recommend that educators teaching Natural Sciences be work shopped by knowledgeable curriculum advisors (teacher development) on how to teach Scientific Investigations LO 1.

And in addition, support should be given to educators on implementing new curricula such as NCS and CAPS ensuring that teacher development is priority. Finally, to ensure that LO 1 can be effectively taught in schools, science kits should be made available to all schools whereas the importance of laboratories cannot be overemphasised.

Key words: Natural Sciences, Construct Science Knowledge, Scientific Investigations, Professional Development

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LIST OF ABBREVATIONS

ACS	American Chemistry Society
BED	Bachelor of Education
CAPS	Curriculum Assessment Policy Statement
CSR	Comprehensive School Reform
C2005	Curriculum which was to be implemented full in 2005
DBE	Department of Basic Education
DO	Dioxide
DoE	Department of Education
ECD	Early Child Development
ECTS	European Credit Transfer System
FET	Further Education and Training
HOD	Head of the Department at school
Grad Dip	Graduate Diploma
IKS	Indigenous Knowledge Systems
IQMS	Integrated Quality Management Systems
NCS	National Curriculum Statement
NOS	Nature of Sciences
OBE	Outcomes-based Education
OBET	Outcomes-based Training
PAC	Practical Argumentation Course
RNCS	Revised Natural Curriculum Statement
STal	Science Teaching and learning
SciCamp	Science Camp
TELS	Technology Enhanced Learning in Science
UK	United Kingdom
USA	United States of America

CHAPTER 1
PROBLEM STATEMENT, RESEARCH QUESTIONS AND BACKGROUND TO THE STUDY

1.1 INTRODUCTION

This investigation focused on educatorsô interpretation and integration of the assessment standards of Learning Outcome 1: Scientific Investigations (DoE, 2002:16) in the teaching of the Natural Sciences in the Intermediate Phase and the influence it had on the designed lesson task, learning facilitation and assessment practices. The purpose of the first chapter is to provide the reader with an outline of the work undertaken prior the actual start of the investigation. It addresses the problem statement, research questions, aim, objectives, relevance of the study, research methods, outline and time frame of the investigation and structure of the dissertation.

The problem statement comprises of reasons why I was prompted to conduct this investigation. I reviewed the literature to get a clear understanding of how Scientific Investigations should be conducted and how the assessment standards are integrated into the teaching and learning process in accordance with Outcomes-based Education (OBE) and the National Curriculum Statement (NCS) (DoE, 2002:16) which were introduced and implemented in South African schools. When the investigation starts, the National Curriculum Statement (NCS) was the policy in operation which was later replaced by Curriculum and Assessment Policy Statement (CAPS). For this reason, the assessment standards in National Curriculum Statement (NCS) were replaced by aims and objectives.

The research questions, aims, objectives are also addressed in this chapter to provide the reader with the purpose of the investigation and to help the researcher remain focused on the investigation. The reader is supplied with the reasons why the study was worth doing and who can benefit from it, in a section about the relevance of the study.

The reader is also provided with an outline of the research methods so that he/she knows how the investigation was conducted. The different research methods as well as reasons for the choice of these methods in this investigation are provided.

The section on the outline and time frame of the investigation informs the reader on how the investigation was planned. Structuring the dissertation gives an indication of the development of the report and forms the major part of the report.

The conclusion at the end of this chapter supplies the reader with a summary of the main points dealt with in the chapter and a brief discussion of its content of the next chapter is also given.

1.2 PROBLEM STATEMENT

Leedy (1993:61) states that victorious academics hold on probing themselves frequently, what am I executing and why is it to be carried out? This question is important to keep one focused throughout the research process. In beginning this research, I asked myself, what do I want to investigate, and for what purpose was I conducting this investigation. I conducted this investigation to determine educatorsô understanding of the National Curriculum Statement (NCS) particularly the interpretation and integration of assessment standards when conducting Learning Outcome 1: Scientific Investigations (DoE, 2002:16) in Natural Sciences in the Intermediate Phase (Gr 4-6). I also focused on the influence that this policy with its assessment standards had on the lesson task designed, learning facilitation and assessment practices.

The reason for conducting this investigation is that educators tended to implement a traditional way of teaching General Science that was content-based. In the past, prior 1994, educators were teaching General Science in the senior primary schools. According to Du Preez and Stroebel (1992) General Science is a subject in which children should be trained as young scientists. Du Preez and Stroebel (1992) further emphasised that educators should realised that General Science is quite different from other subjects as it should enable learners to solve scientific problems. After 1994, General Science was changed to Natural Sciences when OBE was introduced in the South African Education system. In the previous General Science syllabus, scientific investigations were included and specifically prescribed by the Department of Education and Training (1983). However, this syllabus followed direct instruction as a major teaching strategy and assessed learnersô ability to memorise content. Assessment was done mostly at the end of the learning activities and the mainly favoured assessment stratagem was transcribed job like tests and exams (Ramoroka 2006). When Outcomes-based Education (OBE) and the NCS were introduced in the South African education system, a shift in approach meant that educators were expected to change their ways of teaching and assessment. However, despite the introduction of the new curriculum (NCS) and a new approach to teaching, research has revealed that nothing much has changed in the classrooms (Meiring, Webb, Isle & Kump, 2005).

According to Colmer and Daly (2004:268) advanced, continuous pre-service and work-related science educator improvement curriculums are needed to tackle both the philosophies and expertise states of educators, with the circumstantial truths of schools in order to improve applied models.

It is the hypothesis of the researcher that educators do not interpret and integrate the assessment standards well when conducting scientific investigations. This is particularly important with the review of the curriculum and the introduction of a new curriculum, as has been experienced in South Africa firstly with the introduction of the NCS and the subsequent introduction of the Curriculum Assessment Policy Statement (CAPS), initially planned to be operational by 2011, but postponed to 2013.

The NCS for the Intermediate Phase explains that by learning process skills during science, learners improve daily skills within the society and at work. These skills can be achieved in a location that chains innovation, accountability and rising sureness. Learners grow capacity to reason accurately and practice different methods of cognitive and utilise different types of process skills to explore, replicate, examine, manufacture and tell others about the findings. (DoE, 2002:12).

Learning Outcome 1, Scientific Investigations require that the learners be able to inspect contacts and resolve scientific difficulties, technical, ecological perspectives and to be able to perform positively on interest about environmental trends (DoE, 2002: 16). The specific aim is as follows: Investigate phenomena in Natural Sciences which have seven skills to be assessed yearly in the Intermediate Phase. At the end of every year, learners must be able to read and internalise what they have read, put those words in into practice, be able to utilise tools/devices, do some observations, to note figures, determine, and draft a scientific researches (DoE, 2002:14).

At the same time, Technologyôs specific aim is as follows: apply the design process to solve problems which have five (5) skills to be assessed yearly in the Intermediate Phase. At the end of every year, learners must be able to: *investigate a situation, design a solution, construct the final solution, and communicate the process* (DBE, 2010:12-15). With the introduction of CAPS, three learning outcomes in NCS policy Natural Sciences are similar to the three specific aims in the CAPS. In CAPS, Science and Technology have been integrated and work as complementary aspects. Of importance to this research is Specific Aim 1 which relates to ñdoingò Natural Sciences and Technology where learners ñshould be able to complete investigations, analyse problems and use practical processes and skills in designing and evaluating solutionsò (DBE, 2011: 15).

As researcher I considered it vital to conduct research on this specific learning outcome (Scientific Investigations) because the teachers I work with at school teaching Natural Sciences in the Intermediate Phase during our school-based meetings frequently indicated that they have a problem of teaching learners how to conduct scientific investigation as well as how to collaborate and apply the assessment for Learning Outcome 1: Scientific Investigation. During informal discussions with educators and after listening to educators in practice, some educators admitted that they have difficulty understanding the content knowledge and find it difficult to integrate the content knowledge, the Learning Outcome 1 (Scientific Investigations) and the assessment standards. Therefore, the outcomes of this research will be of benefit to me as manager, policy maker, curriculum advisor as well as to the educators teaching Scientific Investigations in the Natural Sciences learning area.

During moderation of the formal assessment, I as the researcher came to realise that Learning Outcome 1: Scientific Investigations is not aligned and integrated with the content and the assessment standard used to assess skills, knowledge, attitudes and values. During Integrated Quality Management Systems (IQMS) evaluation, as the senior in the Natural Sciences, I came to realise that educators, especially in the Intermediate Phase, teaching Natural Sciences, do not interpret the NCS policy document well. According to NCS policy (DoE, 2002:8) competence in the learning outcome is when learnersô quest for scientific investigation for knowledge from material, sources, and citizens, produces goods and questionnaires get information and objects from countryside or business, constructs testable inquiries and objective tests, and clarifies decisions. The learner displays creativity and aims on a minimum of four types of hands-on difficulties (DoE, 2002: 16). The examples of hands on difficulties are as follows:

- Designing difficulty: The researchable question would be ñHow is an electric heater designed? Through this question, a technological skill can be developed.
- Difficulty in taking measurement, doing survey and taking accurate observations: The relevant question would be ñHow can the volume of a dam be measuredò laboratory procedures are acceptable.

- Difficulty in comparison: Which liquid amongst the three is water? Laboratory procedures are acceptable in skill testing.
- Difficulty in the determination of effects of certain factors: what is the effect of hot water when dissolving salt? This can also be done experimentally in the laboratory (DoE, 2002: 16).

As part of the lesson observations during IQMS at school prior this investigation, I examined the lesson designs submitted on templates by educators where the Learning Outcome 1: Scientific Investigations was aligned with the relevant assessment standards. During lesson presentations which I observed at school prior this investigation, learners were asked to describe, name and categorise information which is mostly relevant to Learning Outcome 2: Constructing Science Knowledge. None of the practical problems appeared on the educatorôs lesson designs and learners were not led to search for information from books, resources, generate products, data instruments and questionnaires. Learners were not even guided to create testable questions and to explain conclusions. These issues occurred during most of the lessons I observed as part of IQMS evaluation.

The assessment planned by educators aligned much better with the core knowledge presented, an indication that more attention is placed on the acquisition of Learning Outcome 2 which relates to the Constructing of Science Knowledge. Different types of questions such as naming, defining, classifying and comparing (matching) items form part of learnersô classwork, homework and tests. Based on my observation and discussions with staff, one gets the impression that educators are unable to interpret the policy well because they do not understand what is required of them when conducting scientific investigations.

The assessment guideline document (DoE, 2010) which is used with the NCS policy (DoE, 2002:13-14) shows the process skills which should be part of the preparation (lesson design) and facilitation (presentation) of the lesson and assessment thereof. These process skills include observing and comparing, measuring, recording information, interpreting information and hypothesising to name but few. On investigating the educatorsô preparation (lesson plan), it seems that they tent to list LO 1: Scientific Investigations (DoE, 2002:16) and relevant assessment standards as planning investigation, conducting investigation and collect data, evaluating data and communicating findings (DoE, 2002:16) but contrary to what they have planned, they start describing, naming, defining concepts which are mostly used when addressing LO 2: Constructing Scientific Knowledge.

The National Curriculum Statement (DoE, 2002:3) Grades R-9 (schools) policy from the original Norms and Standards for educators, there are seven responsibilities accomplished by teachers. The responsibilities comprises of being intermediary of learning, translators and makers of learning curriculum and resources, heads, officers and supervisors, researchers, academics and all-time learners, communal members, society and priests, advisors and subject experts.

This investigation focused mainly on the following two roles for educators, inventors and translators of education curriculum and resources LO 1: Scientific Investigation, researchers, and fulltime students (DoE, 2002:3).

Inquiry is the essential experience of science, yet according to Windschitl (2001:113), the immeasurable mass of anew science educators (employed educators who have recently earned their teaching qualification) become educators lacking experience to perform a lone research in which they initiated a researchable request and creating the exploration to respond to that request. Educators` perceptive might impact on how they understand their personal knowledge and thinks that the research they perform alone, the links between their practices, trusts and instructional methods for the study, and technique used to bestow in laboratories (Windschitl, 2001).

One would assume that South African educators are facing the same predicament noted in the study by Windschitl (2001). It seems unreasonable to assume that newly qualified educators will spontaneously embrace the idea of using open inquiry with their own students or feel capable of managing such complex instruction (Windschitl, 2001). The data collected for this research from the educatorœs journals, interviews, observations and during their practice revealed that they have little understanding of the NCS policy.

OœBrien (in Ramoroka, 2006:5) concluded that there is a gap between what educators say they know and what they actually know which has resulted in a call for teacher development. This reinforces Geyserœs argument that:

> *"...educators and other stakeholders must not only familiarise themselves with the new curriculum concepts and terminology, but must look critically at OBE, the cornerstone of the new curriculum"* (in Ramoroka, 2006:5).

By carefully and critically studying the policy documents related to their specific subjects, educators will understand what is expected of them in the classroom during facilitation of teaching and learning and in their assessment practices. Thus, educators will then know how to integrate Learning Outcomes with the assessment standard in the teaching of Natural Sciences in the Intermediate Phase. Besides, educators will also become aware of the philosophical underpinnings of the science curriculum, especially the development of science process skills such as investigate, reflect, analyse, synthesise and communicate (DoE, 2002).

Educators play a major role in the successful implementation of the NCS, in the teaching of Natural Sciences in the Intermediate Phase and it is of vital importance for them to know what is required of them in the classroom.

Vandeyar and Killen (2003:122) explain that:

> *"When we attempt to define what we want students to learn, we may decide that understanding is the capacity to use explanatory concepts creatively, or the capacity to think logically, or capacity to tackle new problems, or the ability to re-interpret objective knowledge".*

This indicates that understanding influences practice and consequently, the interpretation of Learning Outcome 1: Scientific Investigations and the successful integration with the assessment standards will enhance learner attainment of the quality education as envisaged by the Department of Education (2002). But it seems that in practice, educators do not always know how to operationalize the assessment standards (putting it into practice) effectively.

1.3 RESEARCH QUESTIONS

The following research question and sub-questions have been drafted to give direction and focus to the investigation:

How do educators interpret and integrate the assessment standards when conducting scientific investigations in the Intermediate Phase?

In addition to the main research question, the following sub-questions apply to the topic:

- How do the NCS and the assessment policy inform educators on how to conduct scientific investigations in the Intermediate Phase?
- How do educators understand the NCS and assessment policy that inform them on the attainment of the assessment standards when conducting scientific investigations?

- How do educators execute and teach scientific investigations in the Intermediate Phase and does this occur according to the required assessment standards?
- How do educators assess the achievement of the learners in terms of scientific investigations and assessment standards?

1.4 AIM AND OBJECTIVES OF THE STUDY

The aim of the study was to explore educatorsô interpretation and integration of the assessment standards when conducting scientific investigations in the Intermediate Phase. There are *three* objectives which support the aim of the study. The *first* objective was to have a better understanding of the NCS policy on the definition, unique features and scope of the Natural Sciences LO 1: Scientific Investigations and its assessment standards.

The *second* objective was to determine the educatorsô interpretation of the scientific investigations and integration of LO 1: Scientific Investigations, and its assessment standards. To achieve these objectives, a review of the relevant and current literature in this field of study guided the researcher particularly in creating a lens for use during the observations of educators in practice and during the educator interviews.

The *third* objective was to determine how educators designed scientific investigations lessons, integrated them with assessment standards and implemented them in the classroom situation. In addition, their lesson tasks (lesson plans to use the old definition) and how scientific investigations in terms of the assessment standards, were examined.

The *fourth* objective was to determine how educators assessed learnersô performance in the classroom when conducting scientific investigations and how they kept records of their work and the feedback given in the learnersô books. How educators manage their assessment records which will reflect their understanding and implementation of the NCS policy.

1.5 MOTIVATION FOR CONDUCTING THE STUDY AND ITS RELEVANCE BEHIND THE INVESTIGATION

This study investigated how educators interpret and integrate the assessment standards with the Learning Outcome 1: Scientific Investigations in the teaching of Natural Sciences in the Intermediate Phase, the influence this had on the lesson task design, learning facilitation and assessment practices. This study may be useful to policy makers in the Department of Education, curriculum planners, educators, parents and the community at large. But it might also be valuable to subject specialists and officials who have to advise and support educators.

This study might serve as an assessment tool for the success or failure in the development of young scientists, and could also serve as a reflection of educatorsô understanding. It may as well serve as a call for government to emphasise on-going teacher development.

Lastly, this study may serve as a summative assessment, particularly in this scarce field of the Natural Sciences. Within my practice, I was encouraged to study instructional practices in Natural Sciences in South Africa and abroad. But in addition, although it is recognised that knowledge of subject matter does exert a powerful influence on teachersô instructional practice (Shulman, 1986) research also suggests that the nature and quality of education is positively associated with effective teaching (Weber, 2008).

A number of academics in the United States of America (USA) for example, have charged that teacher education lacks academic rigour, placing too little emphasis on theory and academic content whereas practicing teachers, however, have claimed that teacher education programmes fall short on practical relevance. According to Crawford (2000) recent legislative mandates in the USA such as the *no child left behind act of 2001* (p 107-110), have raised renewed concerns about the impact of formal teacher preparation, suggesting that the study of pedagogy in professional preparation programmes has little influence on individualsô ability to teach effectively and that subject matter knowledge is the principal indicator of success in the classroom. I argue that South African educators need on-going development programmes to empower them on not only on academic content but also on practical teaching such as conducting scientific investigation so that they can deliver the subject matter effectively and with confidence and they will succeed in classroom. This is what Shulman (1986) refers to as subject content knowledge and pedagogical content knowledge.

1.6 RESEARCH METHODOLOGY, STRATEGIES APPLIED, UNIT OF ANALYSIS AND CONTEXT UNDER WHICH THE RESEARCH TOOK PLACE

There are different ways in which data can be collected. In this study a qualitative approach only was followed. Observations and interviews were conducted with educators to obtain their understanding of scientific investigations and to find out how they integrate the assessment standards when teaching Natural Sciences in the Intermediate Phase. The method and strategies used in this investigation are discussed in more detail in Chapter 3.

The study took place at five primary schools selected from the following circuits, namely, Kgakotlou, Lebopo, and Mankweng circuit in the Capricorn District in Limpopo province in South Africa. The 13 educators, who were purposefully sampled, teach Natural Sciences in the Intermediate Phase.

However, convenient sampling, involving ñchoosing the nearest individuals to serve as respondentsò (Cohen, Manion & Morrison, 2000:102), was followed as well. The schools were within easy access to the researchersô home. This research was school-based and it may also be seen as cluster-based with the professional development of educators teaching Natural Sciences in the Intermediate Phase, from Grade 4-7. The focus group consisted of educators teaching Natural Sciences from Grade 4-7. The unit of analysis that was accessed during the course of the investigation was science teachers, their notes, daily lesson planning and learnersô workbooks, tests and examinations.

The research was guided by the National Curriculum Statement Grades R-9 (schools) policy document as well as by the CAPS document using the principles, critical and developmental science processes in the Natural Sciences learning area. In South Africa, unlike in USA, the national department of education has all powers centralised with regard to policy implementation whereas in USA every state has autonomous powers to work within education.

1.7 CLARIFICATION OF TERMS AND CONCEPTS

According to Leedy (1993), precise meaning of the terms should be given in relation to the research project. The following terms are defined and used operatively in this study:

1.7.1 Interpretation

The term interpretation refers to actualisation of the concept. Understanding can be realised when educators plan their activities, facilitate learning and assess learner performance. Hermeneutics, as approach towards inquiry, regards interpretation and understanding as essential to all forms of communication.

1.7.2 Understanding

In education, understanding is necessary for comprehension. During reading and discussion, meanings are realised and that is what is meant by interpretation (Möller, Higgs & Deacon, 2003:11). Ekborg (2005:1688) concluded that majority of anew educators cannot create the theoretical perceptive needed to involve through the social and research cases they come across and also argued that numerous anew educators methodology in science matter differs meaningfully from their own understanding, especially for those educators teaching at primary level, and the objectives underneath educator`s syllabus.

During this research, I sought to determine the educatorsô understanding when conducting LO 1: Scientific Investigations, how they integrated the assessment standards and how they assessed learnersô work as well. Skills development in the science classroom is prescribed by curricula and policy documents. The trend not only applies to Europe, but is also applicable to the South African scenario. Decision making is therefore important which in turn relates directly to (Ekborg, 2005).

According to Roehrig and Luft (in Ekborg 2005:1689) aspects like subject matter, opinions on the features of science, lecturing theories and educational understanding are depicted in a cooperative way by research (see also Shulman, 1986). A reduced amount of effort is put on training of anew educators for the duration of procedure modules considered to prepare their perspective area under discussion which is scientific investigation.

Harlen and Halroyd (in Ekborg 2005:1674) stated that research concentrated on educators teaching at primary school, who are generalist than specialist in science, have revealed that they possess delusions alike those of learners they were imparting knowledge to (Cummins, 1993; Shapiro, 1996; Windschitl, 2001).

Researchers like Barker and Carr, Driver, Squires, Rushworth, and Wood-Robinson (in Ekborg, 2005:1673) showed that numerous anew educators in science increase their perceptive of photosynthesis following an elementary science program. Therefore, educators offering science must be sure of their trained improvement of their subject matter. Ekborg (2005: 1673) further stated that youthful people reason in a reasonable manner around photosynthesis; inhalation, and decomposition, leaners do not view photosynthesis, inhalation and decomposition as developments and specimens of chemical responses although sometimes they think that plants grow by gaining water and nourishment or nutrition from soil.

Halldèn (in Ekborg 2005:1674) conclude that educators sometimes provide students with verbal or inscribed order or duties that are later translated by pupils. In order to have insight of what learners are exploiting is to check for the significance of the duties assigned to them.

While operating in scholastic situations educators practices the come to know endeavours to define what learners are performing and pointing at what they should attain.

In their study, Jarvis, Pell and McKeon (2003:17) discovered that numerous educators quit have distinctive delusions that have been recognised previously; regardless the interchanges primary educators` subject matter. Educators too developed an insignificant knowledge of variables and their management throughout an annual training program on emerging and weigh up inquiries.

It was clear from Jarvis et al.ôs study (2003:18) that educators want a full comprehensive perception of the interconnected theories outside the request of the national core curriculum, as deprived of it they may well grow delusions that could obstruct with learners perception and endorsement that job-related teaching wants to be uninterrupted above a significant span of period, to allow wholly educators to extent a scientific perception deprive of which there is a danger that they would endure to acquire delusions. This argument is reinforced by Kruger et al. (in Jarvis et al., 2003:40):

> *"It is difficult to see how a teacher can give children appropriate experiences which enable them to acquire a progressive understanding of science concepts unless the teacher knows and understands what lies at the end of this conceptual development".*

According to Wu and Krajcik (2005:63) if educators are able to understand inscriptions such as tables, graphs and use them well, studentsô interpretation skills will improve as well as their scientific skills. I agree with Wu and Krajcik (2005) and Ekborg (2005) that educatorsô scientific skills as well as their understanding of the inscriptions need development as they are major assessment tools to present findings after experiment were conducted.

1.7.3 Integration

Integration refers to educatorsô linking of the assessment standard with the Learning Outcome, using the content knowledge or strands and assessing the attainment of the assessment standard by learners during assessment methods (DoE, 2002).

According to Chanlin (2008:55) there appears to be a link between technology, technological skills, experiences and the learning process. He argues that learners learn more when they succeed in linking their existing knowledge to the learning process. Technical training should therefore not be divorced from curriculum and instructional objectives. So-called ñtechnology-focused knowledgeò construction should rather be linked to the needs of students and their interests.

According to Wong and Hodson (2008:119) readily available, there is a vigorous interrelatedness of science and know-how skill subject (technology). Learners frequently reason that ñscience comes after technologyò and proceeds in science, carry out advances in technology and technology motivates advancement in science.

In their findings, Wong and Hodson (2008:124) included how contemporary technology has developed how some scientists administer their researches, especially in the biological sciences. ñComputers are used to collect, manipulate and present data, to monitor and control experiments.ò Furthermore, a reliable portrait of an on-going science than voluminous of the systems that presently conquer set of courses time above repeated and inventive usage of technology-favoured and technology-improved research laboratory.

Chanlin (2008:55) also warned that since research has proved safety measures should be reserved in connecting skills transverse the syllabus in technology amalgamation. Educators habitually are unsuccessful to sketch classroom tasks to accelerate learning of located comprehension and a wider knowledge of thoughts. Well-thought-out and performed lessons concerning educators from unalike areas are proposed to generate learners to perceive countless networks and acquire a deep-rooted knowledge of the theories and abilities.

Educators ought to be revealed to the usage of different foundations of web-based resources and function of computer software to write, (data collection), examine, (data evaluation) and show evidence (communicating the findings) in order to impart knowledge to leaners on how to incorporate technology into project based learning and teaching of plain knowledge. I argue that if educators are without understanding of broader scientific concepts, integration of technology into project-based learning, learners will remain untapped.

1.7.4 Implementation

Implement as a verb (v) is a plan/policy which is to be put into effect (Saoneȏs & Hawker, 2000). According to Roehrig and Garrow (2007:1789):

> *"Successful curriculum implementation must provide step-by-step guidance for each lesson in the teacher materials, in order to promote inquiry teaching. In the study involving two high school chemistry teachers, each participated in professional development and implemented the curriculum with sufficient training and guidance to develop reform methods. Student's achievement in their study was found to be positively correlated with the use*

of inquiry teaching about assessed concepts, regardless of teacher experience or school context".

If teachers in South Africa are well trained, given processes and steps to be followed when conducting scientific investigation, they will be able to implement the NCS effectively and learner achievement would improve particularly if inquiry teaching is used.

Powell and Anderson (in Roehrig & Garrow, 2007:1790) stated that syllabus resources give serious backing in supporting educators` execution of extra investigation valuable teaching. From the related literature reviewed by Roehrig and Garrow (2007) it was stated that educators imparting knowledge in an outdated way does not yield intensified perception of theories among the exceedingly talented learners. The teachers belief interview (TBI) was planned to improve decent translation of how educators see learners and the effect which lie beneath views throughout programme execution.

The American Chemistry Society (ACS) (in Bosseler, 2005) listed five essential features of inquiry-based learning: (a) formulate meaningful questions answered in a scientific way (b) design and conduct an investigation providing evidence (c) provide an explanation to answer question (d) evaluate their explanation and (e) share and communicate full inquiry (all features present) or partial (not all features present) inquiry. All these reported features are similar to the assessment standards outlined for scientific investigation (LO1) found in the NCS policy for Natural Sciences in South Africa.

Hofstein, Shore and Kipnis (2004:48) introduced the phases of performance in the chemistry laboratory as follows:

ñ*1- Planning and design (formulating questions, predicting results, formulating hypotheses, to be tested designing experimental procedures). 2- Performance (in conducting an experiment, manipulating materials and equipment, making decisions about investigative techniques, observing and reporting findings). 3- Analysing and interpretation (processing data, explaining relationships, develop generalizations, examining the accuracy of data, outlining limitations, formulating new questions based on the investigation conducted) 4- Application (making predictions about new situations, formulating hypothesis on the basis of investigative results, applying laboratory techniques to new experimental situations)."*

According to Kurki, Boyle and Aladjem (2006:255) numerous educators maintained (The Comprehensive School Reform) (CSR) policy execution whose alterations accelerated enhanced learnersô results, not the simple of a curriculum.

The probability of the fruitful improvement, fruitful improvement of such a curriculum and development in learner`s includes corresponding activities of many performers on several levels: learners, educators, parentages, headmasters, district and provincial supervisors. Consequently, some institutions are further possible to be fruitful in their transformation struggles than others.

A similar programme could be introduced by policy implementers when new policy is introduced in South African Education System. Curriculum 2005 had good intentions but it was poorly co-ordinated at all levels. Every time curriculum is to be used, educators and head masters` leadership abilities can formulate a vast difference. If head masters are drawn in everyday instructional resolutions, they are related with advanced level of execution, predominantly protected sufficient material, and fascinating leaders as well (Kurki, Boyle & Aladjem, 2006).

Slavin and Madden, in Kurki et al (2006:256) state that a curriculum that adds the desires of an institution and is sustained or preferred by headmasters and educators jointly is likely executed more successfully. However, in the case of NCS, this policy was imposed on teachers and it was hastily implemented through a cascade method (Vambe, 2005).

1.7.5 Natural Sciences

Natural Science (s) is one of the learning areas in the NCS Grades R-9 policy which replaced General Science syllabus which operated before 1994. Hereunder follows the definition of Natural Sciences from different perspective. NCS Grades R-9 (schools) policy for Natural Sciences (2002:4) states that:

> *"What is today known as 'science' has roots in African, Arabic, Asian, American and European cultures. It has been shaped by the search to understand the natural world through observation, codifying and testing ideas, and has evolved to become part of the cultural heritage of all nations. Knowledge production in science is an on-going process that usually happens gradually, but occasionally knowledge leaps forward as a new theory replaces the dominant view. As with all other knowledge, scientific knowledge changes over time as people acquire new information and change their ways of viewing the world".*

The introduction of the scientific method by Sir Francis Bacon and the ensuing scientific revolution came to create what is considered science today (Anissimov, 2010). According to DeBoer (2000:583) science turned to be part of the school syllabus throughout the 19th century, both in countries like Europe and USA, and in larger part of the world due to the influences of scientists themselves. On wider outlook, Natural Sciences, is the first of the three (3) splits of science, the second is Social Sciences as the major disciplines. Natural Sciences have sub disciplines and there is integration amongst this afore mentioned sciences. DeBoer (2000:583) further classified the sciences as follows, Natural Sciences as ñhard scienceső due to their objectivity and quantitative procedures. In contrast, the social sciences depend heavily on qualitative valuations which offer findings which are less reliable.

John Dewey (in DeBoer, 2000:583) said:

> *"Whatever natural science may be for the specialist, for educational purposes it is knowledge of the conditions of human action".*

I argue that the importance of Natural Sciences in the South African education system cannot be overemphasised. There is a great shortage of scientific researchers as a result of lack of educators with a deficit of subject content knowledge as well as pedagogical content knowledge of Natural Sciences resulting in a shortage of scare skills.

1.8 OUTLINE AND TIME FRAME OF THE INVESTIGATION

This investigation was aimed at determining educatorsô understanding of LO1: Scientific Investigations and the integration of assessment standards when teaching Natural Sciences in the Intermediate Phase, particularly focusing on the influence it has on the lesson designed, lesson facilitation and assessment practices.

Observations to observe what happened in the classroom and how learners are assessed were conducted. Interviews were arranged to give educators an opportunity to express their opinion freely. Document analysis was conducted to determine the lesson designed, whether they addressed LO 1: Scientific Investigations, how they integrated assessment standards on the lesson designed, how they wrote their facilitation and how assessment was implemented. Data were collected over 10 weeks consisting of observations, interviews and data analysis. When the investigation was completed, data were analysed followed by the writing of the report. Data collection started towards the ends of 23 January 2012 and ended on the 05 May 2012. The task of analysing data was started towards the end of May 2012 and finished in June 2012.

1.9 CONCLUSION

The first chapter addressed the problem statement as well as the research questions that applied to the investigation. The main research question and sub-questions were presented in this chapter. The aims and objectives of the study were also addressed. Concepts such as interpreting (understanding), incorporation (integration), implement, Natural Sciences; assessment practices in the classroom were clarified in relation to how they were used in this investigation.

The following chapter reviews the literature and presents the theoretical framework in terms of the following: Scientific investigations broadly, types of scientific inquiries to be conducted in classroom and assessment practices, policy interpretation regarding NCS for Natural Sciences LO 1: Scientific Investigations. The criteria to assess educatorsô opinion on scientific investigation tasks/projects are also reported in this chapter.

CHAPTER 2
THEORETICAL FRAMEWORK AND LITERATURE REVIEW ON SCIENTIFIC INVESTIGATIONS AND ASSESSMENT STANDARDS

2.1 INTRODUCTION

The purpose of this chapter is to review the literature and outline the theoretical framework of this study. This review will commence by looking at the concept scientific investigations (2.2), the different types of scientific investigations and the assessments standards associated with them. The knowledge gathered enabled the researcher to understand how to plan and conduct scientific investigations, and also how to collect, analyse data and communicate the findings.

The chapter also addresses the theoretical framework and scientific investigations broadly. In this section, scientific investigations (2.2.1), the planning of scientific investigations (DoE, 2002:16) (2.2.2), the conduct of scientific investigations data collection, (DoE, 2002:16) (2.2.3), data evaluating and communication of the findings (DoE, 2002:17) as the assessment standards which should be integrated when conducting scientific investigations is discussed (2.2.4). In addition, scientific literacy (2.3), types of scientific inquiries, types of simple inquiry tasks, various ways of classifying inquiry, experiment as an investigation and as part of the theoretical framework is also discussed. Assessment guide lines and implications for educators were interrogated (2.4) in order to understand the NCS policy for Natural Sciences Learning Outcome LO: 1 which deals with Scientific Investigations.

Section 2.5 introduces the idea of developing a coherent assessment framework for scientific inquiries. This section links to the next (Section 2.6) where aspects assist in acquainting the reader with what the NCS policy for Natural Sciences Learning Outcome LO 1: Scientific Investigations entails. After reviewing the resources, the researcher looked at how Learning Outcome LO 1: Scientific Investigations for Natural Sciences was implemented in South Africa and practiced. The way in which NCS policy was introduced could have impact on educatorsô understanding of how to integrate assessment standards when conducting Scientific Investigations in the Intermediate Phase.

If educators are given enough training (see Section 2.7 on Professional Development), the possibility is that they should understand scientific investigations, integration of assessment standards when conducting scientific investigations in the Intermediate Phase. They should know what to do during scientific investigations in classroom.

If they do not receive adequate training, the possibility is that they should have difficulties with the implementation of NCS policy for Natural Sciences, Learning Outcome LO 1 which deals with Scientific Investigations. The final section of this chapter deals with the theoretical framework designed for this study.

2.2 SCIENTIFIC INVESTIGATIONS

According to Aschbacher and Roth (2002:41), Scientific Investigation involves a progression of discovering the natural or resourceful sphere that directs a request to probe and creating encounters in the quest for modern perspective. The inquiry-based method instruction of science had a lengthy past of growth in the USA and highlighted the up-to-dated science transformations (see American Association for the Advancement of Science (AAAS), 1993 and National Research Council (NRC) 1996).

The National Science Education Standards (NRC), (1996) promoted inquiry as a focal point of science of instruction applauding that learners participate in scientific investigation in order to have abilities and progression related to science, as well as to acquire and develop scientific theories. Chanlin (2008) explains that when undergoing scientific investigation in the SciCamp (Science Camp), elementary laboratory competency were offered such as, how to test acidity and alkalinity for water and melted oxygen dioxide content and water sampling were learned as well by learners. Through these actions, learners gained scientifically approved procedures for conducting Scientific Investigation. The learners were directed by the ñProject Worksheetò utilised to request the following questions: (1) which direction to you want to explore? Why? (2) Which data will you need for the Scientific Investigation? (3) How is your data collection plan? What are your findings? How are you going to communicate the findings?

Luke in Conana (2009:4) defines a Scientific Investigation as ñAn open-ended that integrates science theory within the science discipline in order to encourage higher-order thinkingò being a crucial window on the everyday world through which science can be seen in action (Roberts, in Conana 2009) while Hattingh, Aldous and Rogan (2007:77) refer to a Scientific Investigation:

> *"As an open-ended task, representative of sophisticated learner-centred activity ... classifying these tasks into four (4) levels of complexity from 1-4 in science practical work".*

Haefner and Zembal-Saul (in Conana 2009:4) explain that these tasks emphasise the learning of science as enquiry. Roberts (in Conana 2009:5) states that Scientific Investigation offers a problem in which there is no easily recalled solution and involves the use of both substantive and procedural ideas in a complex task or series of tasks, rather as a particular problem to be solved.

Roberts (in Conana, 2009) sees a Scientific Investigation as a way of showing how experimental science has its roots in a careful, concept-driven view of the real world. Murray and Reiss (in Conana, 2009) state that when learners are involved in a Scientific Investigation, they gain an insight into what science is all about, a sentiment shared by Murphy and Beggs (in Conana, 2009).

Morrison (in Conana, 2009:5) states that Scientific Investigations helps show learners how they can develop their knowledge and skills by using apparatus. Using apparatus in Scientific Investigations provides an opportunity for learners to participate in practical work and to promote good laboratory practices. It also offers learners a chance to experience the reality of a Scientific Research environment. Resources are very important in the teaching-learning situation. Most importantly, Earland (in Conana, 2009:5) states that the exercises in Scientific Investigation should be fun learning experiences, and comparatively free of the normal classroom restrictions. Hughes (in Conana, 2009:8) states that Scientific Investigation stimulates learners because the solutions to the problems and the understanding of ideas in the work they are doing come from them rather than from their teachers.

However, if educators do not understand Scientific Investigations and how to facilitate these, it will be difficult for learners to perform it well. In such cases, learners have then to plan their work, design the investigation, record their results and draw their own conclusions which in many cases may be incorrect or as Richardson (in Conana, 2009) has stated that learners copy the work from the chalkboard and later try to make sense of it.

In this investigation, all educators who participated in the study wrote LO 1ò Scientific Investigations ñ (DoE, 2002:16) on their lesson design and the assessment standard but it seems that the definition as stated by the policy (DoE, 2002) was not correctly interpreted and implemented. The policy elaborates this learning outcome by providing three assessment standards:

- Planning for scientific investigations,
- Conducting scientific inquiry and data collection, and
- Assessing data and communicating findings (DoE, 2002:16)

Each of these learning outcomes is discussed in the following sections.

2.2.1 Planning Scientific Investigations

Identification of the problem to be investigated/change of a problem statement into a focus question/hypothesis (This is an essential step for every research to be conducted).

Ferrance (2000:10) suggests that before embarking on a Scientific Investigation, there must be planning which needs to be guided by questions. The questions should include higher order questioning to develop critical thinking but they need to be stated clearly and be brief enough and frame in simple enough language for the learners to understand. The scientific question should be valuable and be aligned to the curriculum.

Fuchs (2005:49) explains that ñscientists also ask questions to get answers, but they must ask their questions in ways that can be tested through Scientific Investigationsò. This means that some questions are more easily answered than others. Students should learn how to ask questions in the ways that scientists do.

Each question should define a general problem. Students should acknowledge questions which are not appropriate for a Scientific Investigation because they involve personal preference and moral values. However, sometimes questions are appropriate to scientific investigation but need to be rephrased in a more specific form. Scientists recognise two primary types of questions as stated by Fuchs (2005:24) which involves why ñexistence questioningò or how ñcausal questioningò. Educators should be guided by both types of questions but should ensure that causal questioning is predominantly used in scientific investigations.

2.2.2 Conducting Scientific Investigations and Collecting Data

Schwab (in Trumbull, Bonney & Grudens-Schuck, 2005:880) discouraged that science be offered to learners as a firm body of intellectual information, cast down learners from coming up with their own discoveries and accounts of their experiential trends.

Non-existence of expertise with Scientific Investigations reduces the achievement with which learners assess scientific statements. Alternatively, if learners are developed with reliable prospects to operate and lead Scientific Investigations that will empower their competency to productively appraise the difficult scientific views.

DeBoer (in Trumbull et al., 2005:880) monitored that unique changes produced diverse perception of the part of research in science education as well as unique perception of suitable education tactics for gathering research objectives. Research laboratory is a suitable place commonly well-thought-out to advance chances for learners to acquire competency about research. DeBoer (in Trumbull et al., 2005:883) supported by the following researchers (Germann et al., 1996; Herron, 1971; Tamir & Lunetta, 1998; Scwab, 1962):

> *"One might therefore expect reform efforts to have generated a range of laboratory-based activities that successfully involved students' inquiry. Laboratory exercises typically used in schools continue to emphasise confirmatory exercises that require students to follow explicit procedures to arrive at the expected conclusions. Students thus are rewarded for following directions and for obtaining predetermined correct answers. Consequently, students fail to learn habits necessary for conducting Scientific Inquiry, such as observation carefully, using theory and observations to formulate hypothesis systematically, analysing and interpreting data or other aspects of investigations"*

According to Hickey (in Trumbull et al., 2005:881) learners who have deficiency in research could not produce a theory, begin to formulate data collection strategy based on evidence or assess information assertions of other researchers. Developments on curriculum which highlight research are projected to rescue the shortfalls.

Bybee (in Trumbull et al., 2006:883) expanded upon Dewey by proposing three elements of inquiry teaching:

- How research knowledge can support learners to understand subject matter in science.
- How the usage of deeds can offer learners competency to control, lead a research
- To have knowledge of analysing written research enthusiastic researchers.

(Department of Education, 2002:6) states that scientific inquiry allows students to practise learning activities positively in searching for their phenomenon around environment wonders, inquiring interactions, and resolving difficulties in scientific, technological and ecological framework.

When students are able to produce commodities and questionnaires, deal with data collection, constructs problems which are testable and test reasonable views, and clarifies the findings. The students display creativity and lay his or her intellect to hands-on problems like observation and measurements as process skills. Conana (2009:16) states that learners should examine equipment correctly make considerable trials; arrange data logically and in a significant way. Students should be able to observe and convert uncooked data to come up with repetitions, associations between the unknown or illuminate the outcome.

Alebious, Hinrichsen and Jarrett (in Conana, 2009) state that premises will produce numbers through inquiry and depiction which will be the focal point of conversation about consequences, defines that students will be involved in inductive and logical theory and authentication of details created upon a numerous of requirement worthwhile information and abilities.

Fuchs (2005:24) states that researchers in science collect data through recording what they observe and be able to measure. Through repetition of observations or doing anew measurement, which would let to data accuracy if well checked. Learners practise data usage to form description for scientific occurrences.

An important action in choosing the subsequent proceeding which is to be acquired (Ferrance, 2000). Educators must execute several suppliers of data to improve comprehend the extent of events inside their classrooms or institution and encompass numerous tactics for data collection for instance, interviews, field notes, inquiry form, checklists, files and self-assessment.

Ferrance (2000:11) further insists that the following questions should be answered before data collection commences: (1) Are the data simple to gather? (2) Are resources immediately accessible? (3) How organised and logical would the collection be? (3) The use of three resources (triangulation) of data for the core of the movements is mentioned.

Ferrance (2000) however, warns about selecting the data that are most appropriate for the issue being researched. Sandler (in Conana, 2009:48) states that data are fundamental to scientific investigations and by the time learners reach high school, they should be well prepared to collect and interpret data. ñHow will you collect and record your dataò is the question every researcher should ask himself/herself when planning a scientific investigation.

Learners should be able to identify and collect data and all the trends to collect data are recognised insightfully. These trends permit the learners to plan the best way to record their results once they have collected them such as tabling the results, drawing graphs, explaining in paragraphs or describing the results and drawing diagrams that show in proportion a comparison of one thing to another.

2.2.3 Evaluating Data and Communicating Findings

Ferrance (2000:12) argued that as the quest under research directs, educators might like to utilise the classroom data, self-generated data, or mini group data, whichever is relevant and utmost suitable. The quantified data might not be analysed without the utilisation of statistics or practical support whereas other data, like views, feeling, or checklists, maybe sum up in table style. Unquantifiable data could be revised as a whole and of significant elements or themes can be identified.

Ferrance (2000:12) suggests that systemic and logical arrangement of data simplify the identification of trends and themes. It is vital for learners to see main themes during data analyses period. Fuchs (2005:25) explains that learners should learn that scientists communicate their findings in a way that other scientists may try to replicate their effort.

In the South African context, the NCS policy for Natural Sciences Learning Outcome LO 1:

Scientific inquiry is related with research elements of science and embrace as well as other deeds, creating a hypothesis, evolving a strategy for data collection, and forming quarrels proof, all have been deliberated with global literature (DoE, 2002:17).

In discussing Category 4 (communicate the findings), Conana (2009:55) states that this category deals with how learners record and interpret the findings of their investigations. It is an important point at which learners explain in detail their description of the results. Learners understood that communicating is a way of displaying their understanding of the investigation and their work, by recording each step that was followed in the investigation. Communicating the findings occurs in a science report that follows the accepted format in that it is neat, well presented, has a hypothesis, an aim, apparatus, method, recording data, interpreting data and conclusion. This report then forms the assessment.

2.3 SCIENTIFIC LITERACY

DeBoer (2000:582) explains scientific literacy as the word that has utilised towards the end of 1950s to explain a preferred acquaintance with science on the portion of the broader public. Scientific literacy must be intellectualised widely and adequately for confined school districts and single classroom educators to follow the aims that are greatest appropriate for their certain state of affairs along with the subject matter and methods that are utmost suitable for them and their learners (DeBoer, 2000:582).

Bybee (in DeBoer, 2000:582) accepts that scientific literacy may be no additional than a valuable motto to reconvene educators to assist more and enhance science teaching.

In contrast, Shamos (in DeBoer, 2000:591) calls for scientific awareness not scientific literacy:

> *"Because he says it is naive to think that our students can learn to think like scientists. In his proposed science programme, content would be primarily about technology because technology is more useful and easier to grasp than the abstractions of science." Under Shamos`s proposal, scientific literacy would mean: (a) Having an awareness of how the science/technology enterprise works. (b) Having the public feel comfortable with knowing what science is about, even though it may not know much about science, (c) Having the public understand what can be expected from science. (d) Knowing how public opinion can best be heard in respect to the enterprise.*

2.4 SCIENTIFIC INQUIRIES

Scientific inquiries can be categorised in two particular types, namely authentic scientific inquiries and simple inquiry tasks, both of which are discussed below.

2.4.1 Authentic Scientific Inquiry

ñAuthentic scientific inquiry refers to the scientific inquiry conducted by scientists. Its complexity nature requires very costly tools, intricate processes and theories, exceedingly dedicated capability and innovative procedure for data analysis and displayingò (Dunbar, 1995; Galison, 1997; Giere, 1988 quoted by Chinn and Malhorta, 2001).

However, in numerous occasions, especially in emerging countries, institutions do not have adequate time and resources to conduct such research activities. The tricky situation of activities and purposes need more time, money and proficiency to complete. Therefore the activities need to be simple and as well purposes for less time consumption, money and dedicated comprehension would be needed to tackle the problems.

Activities should be simple to attain the required outcome. Unsophisticated activities created and proposed satisfactorily will provide towards accomplishing the best significant constituents related with scientific arguing. Scientific debating is attained by learners when teachers give them with the right activities and projects (Chinn & Malhorta, 2001).

2.4.2 Simple Inquiry Tasks

Simply inquiry errands are seen frequently in the schoolbooks; business books scholastic software and websites of science tasks, and so they are common in the science education countryside (AAAS, 1993). Evaluation by Chinn and Malhorta (2001) indicates that easy investigation integrates little if any characteristics of authentic scientific inquiry. Simple investigation deeds are at one excessive of a continuum that runs to authentic investigation as approved by scientists. The three kinds of simple research activities are:

i. Practical inquiry tasks which are classified into three groups called clear-cut tests,
ii. Easy observations, and
iii. Easy illustrations.

In easy tests, learner administrates easy test usually to check on the relationship between the independent and dependant variables. When easy observations are done, leaners view and explain the objects (see Warner et al, 1991:272). Chinn and Malhorta (2001) describe students observing starfish and identifying different features such as mouth, tube feet, and their location and do accurate measurements where the body part is straight. Through easy illustrations, learners wisely track on a define technique, typically lacking a powerful circumstances, and view the results. Easy illustrations are research activities only in the limited sense.

Confirmation experiences are the lowest level of inquiry or sometimes called ñcookbook labsò in which learners confirm well-known scientific philosophies by succeeding a stated system. (Germann, Haskins & Aulus, 1996). *Structured inquiry* is the research whereby educator does not recognise the solution, and learners are granted technique to keep an eye on in order to accomplish the research (Tafora, Sunal & knetcht, 1980). *In a guided inquiry*, educators give learners a challenge to explore but the approaches for answering the puzzle are assigned to the learners (Wells in Windschitl, 2001). Finally, in *open or independent inquiries/free inquiries*, teachers permit learners to create their personal challenge and propose their personal research (Germann, Haskins and Aulus (1996) supported by Windschitl, 2001).

In the South African context, I would argue that when teaching Natural Sciences to students in the Intermediate Phase, they should be introduced to simple inquiry tasks as good foundation for future authentic scientific inquiry. However, the first step is to develop the educators to practice and perform simple inquiry tasks in the classroom, before they can engage their learners in authentic scientific investigations.

2.4.3 Different Methods of Classifying Classroom Inquiry

The types of scientific inquiry accomplished in the classrooms, such as confirmation experiences, structured inquiry, guided inquiry and open or free inquiries, have been distinguished as follows by science education researchers and are discussed below.

Furtak (2005) indicated a need for scientists and policymakers to discover the part that replies in directed scientific investigation imparting knowledge so that they might enhance to prepare researchers to deal with challenges when they arise in their daily life.

Students as future researchers should always strive to get answers on their own; otherwise they will always rely on the books and other resources for answers whereas they need to learn how to find the answers based on the particular problem. The mentality of óone size fits allô must be discouraged at all cost, but reference of the past must be used to solve the present challenges and anticipate the solution of the future based on the present situation. According to Furtak (2005:465) there is high probability of learners to surrender their tasks and hang on for educators to guide, never mind how elusive, that educators have attained the solution that has been awaited for by learners.

Donnelly (2005) concurs with Furtak (2005) on the problem with the answers, since learners should be inspired to advance their personal hypotheses as an opposed to be instructed to do what is correct. Donnelly (2005:305) further disputed that within the current curriculum reforms, the consistency and authenticity of the idea of science literacy has been abandoned largely not assessed.

Educators teaching science might be puzzled about what composes research (Bumenfeld, 1994; Hudson, 1988 as quoted by Windschitl 2001) with science teachers believing that inquiry is difficult to manage and possible only with above average students. Pomeroy (1993) highlighted educatorôs understanding of the kind of research as an extra inspiration on the shortage of a prospect for authentic inquiry study.

Pomeroy (1993) further indicated that sometimes educators have positivistic opinion of science with numerous thinking in a world-wide beyond a step in the right direction. Abd-El-Khalick, Boujaoude, Lederman, Avi Hofstein, Naiz, Treagust, Tuan (2004) argue the scientific method for doing science investigations dismisses the creative and imaginative nature of the scientific endeavour. Classroom case studies conducted by Carnes (1997), Crawford (1998), Flick (1995), Fradd and Lee (1999) indicated that educators with personal understanding of a research put to use science tuition in styles mismatching the understanding of researchers. The misunderstanding are as a results of various reasons, several commencing in the earlier science discovering places like institutions and pre-service schooling curriculum.

2.4.4 Experiment as an Inquiry

We normally do experiments when testing a hypothesis or when having to determine a known fact (Saoneŏs & Hawker, 2000).

According to Wong and Hodson (2008) significant tests in science are tasks utilised for creating new scientific information and bring about learning stating that ñOur view is that students should be aware of the distinction and role of some laboratory activities in school science as theatreò.

The tests assist learners to suggest questions and unlock new perspective of interest in their thoughts. Tests forms links between thoughts and impressions in the natural world and inspires incorporated thinking in science education (Oguz, 2009). Rohlen and LeTendre (in Oshima Murayama, Takenaka & Yamaguchi, 2004:1200) established activity structures through repeated research in Japanese schools through lessons. Linn quoted by Oshima recorded ten science teachings in five fundamental institutions in Tokyo region and examined them. Their exploration shows that eight regular task structures. Only four selected activity structures which are mostly relevant to my Scientific Investigations (LO 1) were selected for discussion.

In Japanese classrooms, science teachers prepare their teachings utilizing structures relaying on their learners` features and conditions in the schoolroom. (Oshima et al, 2004) whereas in the South African context, the activity structures are called assessment standards: 1. Plan investigation, 2. Conduct investigation, 3. Exchange information from investigation. 4. Systematically analyse or organise information.

2.5 THE DEVELOPMENT OF A COHERENT ASSESSMENT FRAMEWORK FOR SCIENTIFIC INQUIRY

Liu, Lee, Hostetter and Linn (2008:35) argued that there is a demand for sound science assessment. They developed a hidden concept named information combination as an active portion of scientific research. Information combination evaluation request learners to connect, differentiate, assess and categorise their views about complicated scientific topics.

According to Liu et al (2008:52) researchers like Black and Wiliam (1998) have named for an extra reasonable evaluation framework. Educatorsô interpretation and integration of the assessment standards should assist them in modelling instruction; giving problem-solving to educators, demonstrating complicated thinking, and encouraging numerous problem-solving skills.

However, challenges to developing such a framework with relevant assessment standards located in numerous pleats: shortage of intellectual fundamentals, weakly explained theories, discontinuation between evaluation things and focus construct and overgeneralised recording rubric as they are countless. The educatorsô misinterpretation and disintegration would compromise the understanding of the outcomes, the effect of the conclusion and the confirmation of the assessments. Assessment supports the learning aim of constructing consistency through the collection of views rather than concentrating on disconnected ideas. Assessment improves the condition of complicated thinking in the schoolroom and motivates educators to boost analytical thinking during their curriculum application. Nevertheless, assessment confined to schoolroom must be planned and carried out to calculate the complicated scientific perspective while staying compactly associated with the teaching empowering the view that assessment encourages learning instead of scarcely showing learning (Black & Wiliam, 1998).

As Millar and Osborne in DeBoer (2000:599) suggest in Beyond 2000 that:

> *"The critical principle that must guide any assessment framework adopted for the science curriculum must be that assessment should exert a positive and benign influence on the teaching and learning of science".*

The Technology Enhance Learning in Science (TELS) states that assessment illustrates ways to plan tests that are cognitively normal and subsequently, connect well with the technical benchmark.

DeBoer (2000:590) reports that subsequent to the journal of Science for all Americans, The National Academy of sciences consolidated the forces to make sure that the entire student community realise science literacy. At the beginning of 1992, the US government introduced the National Science Education Standards [NRC] (1996) as an attempt to education transformation, methodology that encompasses establishing national aims and benchmarks to be met. The purpose of the National Standards was to make sure that the entire student community attain science literacy by conquering a collection of content benchmark. Students who attained the content benchmark would be regarded as scientifically literate. Hereunder follows the five statements which validate the recognition of the content benchmark.

1. Scientific knowledge should be used by every individual when making choices on daily basis.
2. Every individual should be able to participate wisely in public dialogue and argue about vital matters that encompasses science and technology.
3. The knowledge and learning about wonders of the universe should be shared with stimulation and individual pleasure.
4. Numerous job opportunities require sophisticated capabilities, expecting that an individual is able to learn, argue, think analytically, make calculated decisions, and resolve difficulties. The acquirements of the above abilities are of paramount importance in the understanding of science.
5. For United States to be internationally competitive, its citizens should be scientifically efficient (National Research Council, 1996:1-2).

The influence of benchmark based education must be useful. If the benchmark give educators a resounding feeling of what is vital and direct the improvement of curriculum in progressive ways, they are valuable. If educators generate a learning situation that is extremely restraining, then both subject matter and assessment benchmark want to be reconsidered as a relevant tool for following the aim of scientific literacy for all.

The above five content benchmark are the same as the crucial results encouraged by the South African Constitution and advanced in an egalitarian process and moreover in the NCS forming its learning results for General and Training Bands for Grades R-9 (for schools) (DoE, 2002:1-2).

Assessment benchmarks are technique in which learners show their success of all three Natural Sciences Learning Outcomes. LO 1: Scientific Investigations is one of the three Learning Outcomes with the following assessment standards:

1. Planning of scientific investigations,
2. Conducting scientific investigations and data collection,
3. Evaluation of data and communication of the findings (DoE, 2002:16)

In Curriculum 2005 (C2005), Learning Outcomes were regarded as curriculum controllers located at the centre of FET and Foundation Phase levels. From Intermediate phase and senior phases, nonetheless Learning Outcomes together with assessment benchmark are the controllers of learning.

The tricky was that the requirement of Learning Outcomes, assessment benchmark and content benchmark were unequal through learning areas, subject matter and ranks with Learning Outcomes concentrating on development (such as in Technology and Natural Sciences). Moreover, the Learning Outcomes are chosen to operate transversely from Grades R to 12. The team contended that it is not important to have similar Learning Outcomes transverse from all points, but that might create extra awareness to choose the abilities, subject matter and views most relevant to learning at altered stages and indicate these well (DoE, 2002). The requirement in both the Learning Outcomes and assessment benchmark is rough, as are the means in which these learning areas show development, particularly exhausted in Natural Sciences.

Assessment benchmark is the other controlling tool for the curriculum form the centre, are envisioned to show development and display the technique in which the Learning Outcomes may be attained. Agreeing during proposal sittings, assessment benchmark were claimed to be too many, sometimes unclear, and reduced in the coverage they show development. The studentsô performance level was also not clearly indicated. All these flaws and many other challenges not mentioned in this project let to the replacement of ñRevised National Curriculum statement (NCS) by the Curriculum and Assessment Policy Statementò (CAPS) in 2011 as planned (DBE, 2009).

According to CAPS (Curriculum and Assessment Policy Statement) Intermediate Phase Natural Sciences and Technology final draft (2011: 10), LO 1:1 which deals with Scientific Investigations correlates well with specific aim:

1.2. Understand and make meaning of the Natural Sciences and Technology. The Department of Basic Education (2011) states that learners must acquire skills to analyse assess gained information and integrate information to start new value through transcribed sum ups, movement charts and brainpower maps.

2.6 THE NATIONAL CURRICULUM STATEMENT (NCS) POLICY FOR NATURAL SCIENCES (R-12) INFORMS EDUCATORS ON CONDUCTING SCIENTIFIC INVESTIGATION

In this section, the roles outlined for educators in the NCS policy is discussed which leads into a discussion of the NCS policy of scientific investigations for Natural Science at the Intermediate level. Finally, this section highlights the significance of integrating the science process skills during scientific investigations.

2.6.1 Roles Outlined by Norms and Standards for Educators in the NCS Policy

All teachers are major providers to the change of curriculum in South Africa. The Revised National Curriculum Statement Grades R-9 (schools) foresees educators who are trained, skilled, committed, and devoted and be able to carry out different characters sketched out in the Norms and Standards for Educators. These characters embrace being facilitators of learning, translators, planners of learning schedules and resources, managers, governors, officials, overseers, academics, intellectuals, specialists, communal member, civic member, priest, evaluators, learning area experts. In this study, I focused on following characters facilitators of learning, translators and planners of learning schedules and resources managers, governors, officials, overseers, academics, intellectuals, specialists and the kind of teacher envisaged by NCS policy (DoE, 2002:3).

Scientific investigations expect learners to be able to do things assertively on inquisitiveness about environmental occurrences, and explore connections as well as resolving difficulties in scientific, technical and conservational frameworks. Currently, Revised National Statement, advancement is shown not only in terms of the information a student can remember.

Somewhat Learning Outcomes 1, 2, and 3 are manipulated to evaluate development in studentôs capabilities to design and conduct an inquiry including information, and the competency to translate and implement that information in the schoolroom circumstances involving the students as an associate of a transforming citizens (DoE, 2002:7).

2.6.2 Interpretation of LO 1: Scientific Investigations

According the NCS Grades R-9 (schools) Natural Sciences policy (2002:8):

> *"Competence in this learning area can be seen as the learner searches for information from books and resource people generate products and questionnaires, collect data and materials from nature or industry, creates testable questions and fair tests, and explains conclusions".*

According to the Department of Education (2002:9), the NCS policy on Scientific Investigations expects learners to solve four types of concrete problems: The examples of hands on difficulties are as follows:

- Designing difficulty: The researchable question would be ñHow is an electric heater designed? Through this question, a technological skill can be developed.
- Difficulty in taking measurement, doing survey and taking accurate observations: The relevant question would be ñHow can the volume of a dam be measuredò laboratory procedures are acceptable.
- Difficulty in comparison: Which liquid amongst the three is water? Laboratory procedures are acceptable in skill testing.
- Difficulty in the determination of effects of certain factors: what is the effect of hot water when dissolving salt? This can also be done experimentally in the laboratory (DoE, 2002: 16).

Progress in this Learning Outcome (LO 1), which deals with Scientific Investigations, is perceived in terms of rising capability in sensing, defining and challenging interactions between variables. The assessment benchmarks display this progression in capability. The assumption is that by Grade 9, the students have better perception of a variable as a cause which might alter in the other. The students should be able to utilize that information to easy worries. The students thinking, inquisitiveness and capabilities to request better probing questions will enlarge and widen. The studentôs ability in starting hands-on work and assess the inquiry or mediating whether an inquiry acceptable or not.

Inside LO 1: Scientific Investigations, the results are regarded as partly attained if students perform assertively, inquisitively about environment trends, and to translate connections and problem resolution, technical and conservational background (DoE, 2002:9).

2.6.3 The Integrating of Science Process Skills in Scientific Investigations

According to Collette and Chiappetta (1986:71) science process skills are utilised in all types of laboratory work, but in some instances they are specially emphasised, with the attainments of these skills being the intended outcomes of the laboratory activities. Science process skills are divided into ñBasic *Process Skills* and *Integrated Science Process Skills"* (Van Rooyen & De Beer, 2007:69) as illustrated in Table 2.1.

Table 2.1: Basic and integrated science process skills

Science Process Skill	Definition
	Basic Science Process
Observing	Seeing the properties of items and circumstances using the five senses.
Classifying	Connecting items and events according to their properties or attributes.
Space/time relations	Imagining and operating items and events dealing with shapes, time, distance and speed.
Using numbers	Utilising quantitative connections, e.g. scientific notation, error, significant numbers, precision, ratios and proportions
Measuring	Uttering the amount of items or substance in quantitative terms, such as meters, litres, grams, and newton's.
Inferring	Presenting an explanation for a particular item or event.
Predicting	Forecasting future happenings based on observation or the extension of data.
	Integrated Science Process Skills
Defining operational	Improving statements that show a concrete depiction of an object or event by reeling one what to do or observe.
Formulating models	Constructing images, items or mathematical formulas to explain ideas.
Controlling variables	Manipulating and controlling properties that relate to circumstances or events for the purpose of determining

Science Process Skill	Definition
	causation.
Interpreting data	Arriving or reasons inferences or hypotheses from data that have been presented or placed in a table.
Hypothesizing	Expressing a tentative generalization of observations or inferences that may be discussed, a relatively larger number of events but that is subject to instant or eventual testing by one or more experiments.
Experimenting	Examining a hypothesis through the management and handling of independent variables and noting the effects on a dependent variable. Interpreting and presenting and presenting results in the form of a report that others can follow to replicate the experiment.

Van Rooyen and De Beer (2007:69) and Collette and Chiappetta (1986) have reported on science process skills which are include in all three science learning outcomes of the NCS, namely Scientific Investigations, Constructing Science Knowledge and Science, Society and the Environment. Process skills can be grouped into two types that are hieratically organised: the primary (*basic*) and the integrated (higher-order) process skills. The basic skills are the simpler of the two, and provide a foundation for the acquisition of the more complex integrated skills (Van Rooyen & De Beer, 2007:69).

A. **Basic science process skills** consist of the following:

- Observing
- Inferring
- Measuring
- Communicating
- Predicting

B. **Integrated science process skills** consist of the following:

- Controlling variables
- Defining operational
- Interpreting data
- Experimenting
- Formulating models
- Formulating hypotheses

If teaching is taken as a point of departure, process skills could be regarded as the constructing blocks which are good for science activities formation. A structure of process skills to plan requests which encourage the types of rational needed by learning results. If learning is regarded as a point of departure, process skills are vital and ways needed by the students to debate with the globe and attain sophisticated command of it by the construction of theories. A structure of process skills is also cherished to educators in assessment, whenever they plan measuring scales, correcting guide and tools to capture the performance for student who takes part daily. óProcess skillô is defined as the studentsô thinking tasks of generating sense and a framework from new knowledge and proficiencies. Process skills are such as observation skill, taking good measurement, data classification, doing inferences and developing questions for inquiry. The NCS Grades 4-6 Natural Sciences (DoE, 2002:13-15) set out a group of process skills which are vital in outcomes-based science and offered hereunder:

- *Creating questions regarding the circumstances* regard deep thought on questions to be asked regarding the circumstances, realising a quest which the solution could be found through scientific research (as contrary to requests which science would not offer solutions) or changing the quest to be tested through science.

- *Designing scientific research* comprises of various capabilities as stated above and is the assessment benchmark on its own. The students should develop the ability to change the problem statement into researchable hypotheses, relating the variables well when getting the solution to the problem, considering the dependent and independent variable, not ignoring the constant variable as well. Designing the tools to be used for measuring the entire variable and be able to do inferences regarding their own results (or the results from other researchers).

- *Performing a research* is an assessment benchmarks, whereby students study the variables involved in a research, differentiate the variables like those which need to be observed, from those variables which need measurement, and check the inferring variable which only need to be controlled during the research. After data collection, the same data is interpreted to find the solution which must be presented qualitatively and quantitatively.

- *Transferring science knowledge:* there is a direct link between this skill and critical outcome 5 (effective visual communication, symbol/and or skill for language from various modes) communication capability encompasses the ability to know when to do an addition to the other persons view or outcomes, selecting the correct way to send the message to the relevant listeners. In science laboratory, students may use this ability to communicate orally through English language, by writing summary, drama, comic strip, through an art on posters as well as on pie-charts.

- *Communicating (Transmitting)* includes further established science kinds like tables, the connecting ideas, graphs, word-webs, making materialistic models and as well as using students to depicts the movement of planets round the sun. ñThe Natural Sciences Learning Area Statement addresses the Critical and Developmental outcomes through three (3) Learning Outcomes. There are ten (10) Assessment Standards covering the three (3) learning outcomes.ò (DoE, 2002:13-15)

2.6.4 Assessment Framework, Assessment Strategies, Assessment Tools, and Forms of Assessment for Scientific Investigations

The assessment procedure is an operative method of transmitting the opportunities of the Natural Sciences learning area and gauging what students perform and understand in science. Assessment offers students response on how good they are encountering the prospects explained in the learning results and assessment benchmarks.

The response directs to variations in the instruction and acquiring of the Natural Sciences information, ability, believes, thoughts are evaluated in a good way. Other types of evaluation are good to test the natural surroundings of the learning area Natural Sciences. Educators must look for assessment advices for the types of assessment suggested. Educators are inspired to offer students with a chance to do authentic assessment.

Authenticated assessment activities need students to utilize scientific information and interpreting to circumstance common to they would come across in real life outside school room, similarly to places scientists world of experimenting. Assessment activities should be developmentally suitable, should be preparing in the students common background, and should not test the learnersô vocabulary or reading ability relevant to the class level. Assessment should be unbiased.

Therefore, improvement of assessment activity is directed by assessment benchmark and fundamental information, and perceptual structure. Educators should make sure that assessment activity are elaborated for all the components and must practice the native information to which students know already. Good performance by students will inspire them to go on acquiring in Natural Sciences. Nonetheless, assessment activity should be suitably improved to adjust the requirement of numerous students; consideration should be made to students with learning obstacles and with very few materials (DoE, 2002:25).

The aptitude of imparting knowledge called for a complicated artefact or characters in which numerous abilities and considerable information is amalgamated, and what is complete, reliant on the type of difficulties encountered. Knowledge imparting is a competency acquired and developed over the years but although competence increases with experience, teaching proficiency does not reach an end-point. Learning Outcome 1: Scientific Investigations (DoE, 2002:6) states that: ñThe learners will be able to act confidently on curiosity about Natural phenomena, and to investigate relationships and solve problems in scientific, technological and environmental contextò. Learners at elementary grades may display inquisitiveness and explore an environment happening, like seeds growing. Elementary grade learners would do simple inquiry. In Grade 12, the same students may explore similar trend at innovative levels, cautiously well-ordered tests.

Some students, for some reasons may leave school and turn out to be research scientists, exploring the similar happening at the university level in conjunction with academics in other country, and putting up plant growth trials that are conducted in the world wide solar system station. According to Department of Education (2002: 22) Learning Outcome 1 is never ñrealisedò, students improve if practice it frequently. Because these outcomes are composite, the same will apply to the Learning Outcomes 2 and 3. Assessment should be aimed at improving studentsô better performance. At elementary grade level, learnerôs ability to measure using a ruler should be evaluated as ñcan do/canôt yet doò to indicate the achievement of that specific competency (DoE, 2002: 22).

The assessment structure of the NCS for Grades R-9 (schools) is rooted on the philosophies of Outcomes-Based Education (OBE). OBE was revised by the then Minister of Education and it became known as the Revised National Curriculum Statement (RNCS). NCS was adopted after the letter R was removed from RNCS.

Assessment must offer signs of studentôs attainment in the utmost operative and capable way, and make sure that students interconnect and implement information and abilities. Assessment must assist learners to construct decisions about their personal execution, group aims for progression, and aggravate further education. Assessment can be conducted utilising dissimilar types or kinds of tasks that students are requested to perform, in turn to display capabilities and abilities. Later, a ruling must be taken whether the task assist in formative or summative reason. Educators must choose the type of assessment relying on the intention of the assessment. The selected kinds of assessment must give a scope of prospects for students to show accomplishment of information, ability, views, and feelings. The following forms of assessment are recommended, to support the development of assessment tasks specifically in the Natural Sciences Learning Areas. LO 1 can be assessed using the following forms of assessment:

- Investigation activities
- Projects
- Research
- Practical demonstration

There should be a direct link between the kind of assessment and the Learning Outcome to be evaluated. For the assessment to be acceptable (so that it evaluate what it was required to evaluate).

Educators must not attempt to evaluate scientific hands-on ability only with the paper and pencil transcribe trail. The type of assessment must match the intention of the assessment. The prepared lessons must include amongst others the following words:

- Focus question
- Conduct simple tests
- Record and response
- Relate observation and response (DoE, 2002:22)

Assessment equipment for verifying learner attainment is important. Because, there are numerous assessment equipmentôs that can be utilised to verify learnerôs attainment. The utmost significant assessment equipment for Scientific Inquiry (LO 1) is checklists, scale, rubric, reflection sheet (with criteria) (Assessment guidelines for Natural Sciences Intermediate and Senior Phases (DoE, 2002: 22, 35).

Many educators do not keep comprehensive records to provide satisfactory information concerning learnersô performance in the classroom. Educators keep records of preparations, marks sheets, tests and memoranda but few are relevant to LO 1: Scientific Investigation.

Siebörger (in Ramoroka, 2006:97) argues that recording may serve as evidence for assessment. This means that well-kept records can help educators to see whether there is improvement in learnersô performance or not. Most educators experience difficulties when it comes to using recorded marks for learner`s results.

Tiley (in Ramoroka, 2006:102) takes observation, recording and reporting as basic elements of continuous assessment. Educatorsô records can help them report on the learnersô progress in three ways namely: educatorsô own record book or mark book, portfolios of learnersô work and learnersô profiles (DoE, 2002:80).

According to the Department of Education (2002:81), educators should keep the following assessment records: record book in which they keep students names, dates for assessment, explanation of evaluation tasks, assessment tasks outcomes learnersô names, dates of assessment, description of assessment activities, the results of assessment activities corresponding with to learning areas, and notes for support reasons learner portfolios; progression schedule and learner profile. Most educatorsô records are often not up to date. They do not describe the assessment activities that were given to learners. They only record learnersô marks after giving them tests. There is no evidence that educators give support to learners who fail to achieve the desired outcomes.

Assessment in the school room is still conducted as only transcribed task. The method of questioning remains unchanged as teachers keep an eye on the old-style methodology. Test for memorization on student still dominated.

2.7 PROFESSIONAL DEVELOPMENT FOR EDUCATORS

Educators should also engage in professional development activities in which they improve their qualification. Tertiary institutions equip educators in pre-service training with necessary skills and knowledge to implement the curriculum. If the education systems change, tertiary institutions should also adapt their curriculum to align with the changes. If educators engage in further studies, they will acquaint themselves with the changes taking place.

Gilmore (in Ramoroka, 2006) argues that planned professional development opportunities increase educatorsô assessment capacity. Educators who engage in further studies are updated with changes taking place in the education system. Knowledge keeps developing and as such, this influences change in curriculum development. As curricula keeps on changing, qualifications and training achieved in one year may not be useful in ten years to come.

It is essential for educators to improve their qualification so that they can remain up to date with changes in the curriculum. If South African teachers are well trained, their individual interest would be revived and they will, as a result, teach with confidence and learnersô results will improve. Research done by Skamp (1992) and Trumper (1998) indicated that numerous elementary school educators under elementary schooling have little science information and showed displeasure in science, particularly the physical science and this impacted negatively on their studentôs opinion to science.

The NCS outlines the assessment standards for scientific investigations in the Natural Sciences, requiring learners to plan the investigation, collect and interpret data and communicate findings. However, teachersô lack of knowledge yields the negative feeling and tends to dominate studying throughout tutor instruction (Tosun, 2000). This results in the teachersô shortage assurance in their capability to offer subject matter which this has indeed become a problem because teachers in primary education with negative attitudes have been a focus of research conducted by Akerson and Flanigan (2000) and Yates and Goodrum (1990).

According to Shulman (1986, 1987) teachers should be taught content knowledge and methods for teaching science which could increase their confidence and arouse their situational interest and develop a positive attitude, particularly if they understand and develop pedagogical content knowledge of Natural Sciences.

Educational implication proposes that situational fascination is a concept that supports worth for science education. Workshops where teachers become engaged in practical tasks, innovation, and significance (across knowledge how to offer science, and opportunity through perception of theory they want to imparting knowledge) company task (through practical tasks) and individual narratives. The improvement of situational fascination could then promote science inquiry (Kanari and Millar, 2004).

2.7.1 Developing Educational Theory for Natural Sciences Educators

According to Loughran, Mulhall and Berry (2008:1301) educatorûs scholastic subject matter is regarded to be an aim of tutor schooling, whereas instruction around the theory itself is atypical practice.

There appears to be worldwide discontent with ñeducational theoryò given by universities. Pedagogical content knowledge appears to be one of those education theories (Skilbeck & Connell, 2005). Students in Lougranûs study found it difficult to understand content representations and pedagogical-experience repertoire conceptualisation. Pedagogical knowledge in Science Education is regarded by many as an ñeducational theoryò. It is a hypothetical paradigm that was presented by Schulman (1986, 1987) as a technique of explaining the specific shape of subject matter utmost connected (information that could be acquired) to its instruction capabilities and that consists the methods of demonstrating and creating the subject matter that cause it understandable to others (Schulman, 1986:9)

In other words, this means that teachers should be taught how to teach the subject content using techniques and strategies that are appropriate to that particular subject. When the OBE approach was introduced in South Africa, it was difficult for teachers to understand the terminology and the many specific outcomes to be addressed. Ultimately Natural Sciences emerged with three (3) learning outcomes, namely Scientific Investigations, Constructing Knowledge and Science, Society and Environment.

The educatorsô interpretation of the LO 1: Scientific Investigations and the assessment standards thereof influence educator`s assessment practice and their understanding of Scientific Investigations and integration of assessment standards would enhance the learnersô performance.

Mutereko (2009) identified different approaches to policy formulation and implementation. He further identified that when OBE and NCS were implemented, the policy makers tended to bypass the bureaucracies and street-bureaucrats (educators) on important issues such as their ideas, values, beliefs and interest which they also use to shape policy. The majority of street-bureaucrats (educators) during the implementation of NCS have values and values which were shaped by and in the apartheid education system. A total change of these values does not take place overnight.

Parsons in Mutereko (2009:13) outlined the developments of major policy approaches over the last decades.

- The analysis of failure.
- Rational (top-down) models to identify factors which affect successful implementation.
- Bottom-up critiques of top down model in terms of the importance of other actors and other organisational interactions.
- Hybrid theories. Implementation as evolution.

The third approach (Bottom-up critiques of top down model in terms of the importance of actors and other organisational instructions) is relevant to this study as for Mutereko̻s (2009) study. Pressman and Wildavsky (in Mutereko, 2009) argued that when implementing a policy, goals have to be clearly defined and understood, and resources made available (Mutereko, 2009).

Parsons in Mutereko (2009:15) outlined five conditions for perfect implementation in a top-down approach as follows:

(1) Ultimate application is a result of a unitary ñarmyò like organisation, by way of perfect lines of power.

(2) Standards would be imposed and intentions prearranged.

(3) Societies would be to make what they are informed and requested,

(4) Flawless communication must be maintained between parts of the organisation.

(5) In no way shall people be pressurized due to time constraints.

As the researcher, I agree with Mutereko (2009) that it is difficult to imagine that an educational policy can be implemented by teachers in such a fashion as outlined by Parsons (in Mutereko, 2009) above. Mutereko (2009) regard educators as street-level bureaucrats who enjoy a high degree of discretion and autonomy. Principals, circuit managers and district senior managers as supervisors work differently front line of workers with no or little discretion. In many respects, teachers do not do as they are told.

Teachers have limited resources or no resources at all in some instances, and they work under pressure to finish the syllabus and to update their records (Mutereko, 2009).

Mutereko (2009:15) summed up his argument by saying:

> *"Everything is good when it leaves the Creator's hands; everything degenerates in the hands of man. Similarly, the policy is good when it leaves Pretoria and it degenerates in the hands of schools and street-level bureaucrats".*

If the policy does not produce the desired outcomes the street-bureaucrats (educators) are to blame. Lastly, Parsons in Mutereko (2009) set out some of the conditions (commandments) that are necessary for a top-down approach to achieve the desired policy outcomes:

- Situations exterior to the execution organisation do not impose.
- Enough time and plenty assets are brought about initiate and outcome.
- The policy to be implemented is based on valid theory of cause and effect.
- Those in authority can be demand and obtain perfect obedience.

The lesson designing and facilitation will be compromised if educators are lacking the understanding of the curriculum in Natural Sciences. In their conclusion, Loughran, Mulhall and Berry (2008:1316) have deliberated on how an overt concentration on instructive subject matter information in pre-service science educator education might impact student teachers on and methodologies to practice.

Although the student-teachers used in Lougranồs study were well qualified, he called them the ñBEDsò and ñGrad Dipò respectively, but they needed a teaching practice programme to become better teachers, who could design, facilitate the learning activities well and even assess accordingly. Loughran et al. (2008) suggest that concepts such as planning investigations, collecting and interpreting data as well as communicating findings, should be well interpreted and integrated with the learning outcome.

2.7.2 Aligning NCS Policy, Practice and Assessment by Educators

Dekkers and Mnisi (2003:32) argue that one has to establish in-service programmes to help teachers develop an adequate understanding of the NCS as an appropriate pedagogy. Hattingh, Rogan, Aldous, Howie and Venter (2005:21) indicate that in sequences of case studies managed during throughout 2004 year, it was discovered that the space between the envisioned and executed curriculum was huge, as Rogan had contended in his research.

I personally think that educatorôs development is vital especially those educators teaching Natural Sciences in the Intermediate Phase and scientific investigation been the area of focus. Dekkers and Mnisi identifying the mis-alignment of syllabus procedures and to put it into practice have contended that studentôs execution will be influenced if what really occurred in the schoolrooms is badly united with the expected policy. The alignment problem must be taken into account in imparting and acquiring knowledge and above all when planning tools for gauging students attainment.

Vandeyar and Killen (2003:119) indicate the guidelines for assessment that are consistent with the principles of high-quality assessment for example, reliability, validity and fairness, are embodied in the NCS curriculum. Although research has claimed that teacher do assess learners as a matter of technical procedure, something that must be done to satisfy the bureaucrats, the focus should shift to the matter of professional judgement, something that should be done to help students learn based on assessment (Vandeyar & Killen, 2003:133).

In their findings, Furtak and Ruiz-Primo (2006) showed that the consistent use of informal formative assessment (question, follow-up, leading question) has had an effect on improved student performance during post-test scores and scientific inquiry. Thus, teacher training and development of assessment should be looked at in the light of increasing learner understanding and performance.

2.7.3 Undertaking the roles of Scholars, Researchers and Lifelong Learners (self-development)

Lortie (1995) argues that the entire occupations, teachers have the prolonged internship of learning by staying students and by noticing educators for numerous years. Russel (1993) further states that educators themselves are yields of out-dated K-12 education where they, as students, were often open up to educator-focused instruction, fact-based content, and train and practice. According to Kennison (1990) these know-hows provide forthcoming educators with rational sculpts of teaching which they utilise to envisaged lessons in their individual schoolrooms, acquire improvements, and learning results. Educators are with a reduction of probable to be directed by instructional philosophies than by acquainted pictures of what is ñproper and possibleò in schoolroom sceneries (Russell, 1993; Zeichner &Tabachnick, 1981).

Shapiro (1996) in a research performed with fundamental science procedures classroom discovered that 90% of her learners had on no occasion faced science as a research. This observation applied specifically to those students who had attended school science fairs.

Educators` conceptions in scientific inquiry can be influenced by beliefs about inquiry, by working in laboratory settings, and by coursework in teacher education.

When the NCS was implemented in South Africa, educators attended workshops for few hours a week and mostly admitted that they were not well equipped with the necessary skills to understand the NCS policy. The Department of Education policy document (2002:4) states that teachers are fundamental to the alteration of the schooling in South Africa but change is difficult and it seems that change in classroom practices appears to be an on-going challenge, particularly as the implementation of Outcomes-based Education and Training (OBET) is enmeshed in this immense process with its accompanying problems (Terence & Smith, 2009).

The prevalence of this ñimplementation problemò provoked McLaughlin (in Weber, 2008:26) to research why schoolroom exercises are so difficult to transform. Mitchell and Koediger (in Weber, 2008:26) argued that:

> *"Previous effort at curriculum and instructional reform has fallen short partly because reformers neglected to consider the decision-making process of teachers".*

Schulman (in Weber 2008) states that cognitive approaches to reviewing syllabus change are premised on two suppositions. The first one, the schoolroom activities and manners of the educators are mainly formed by their feelings, verdict, and resolutions and secondly, the findings of the educator rational and verdict rendering, composed with setting in which they work, give a good perspective of why educators perform what they achieve in their schoolroom.

The same sentiments are shared by Borko, Livingston and Shavelson (1990) who explain that for educators to implement the curriculum successfully, they must understand the integration between learning outcomes and assessment standards using a particular content accordingly. Fazio and Melville (2008:193) identified two critical goals of scientific literacy as students` engagement and expertise in scientific inquiry, and the development of a reasonable conception of the philosophical and social underpinnings of the nature of science. I believe that if educators are engaged in real action research, like the teachers investigated by Fazio and Melville, the designing of tasks and classroom facilitation should improve, and thus assessment practices should yield good results by improved learners performance.

The collaborative action research conducted by Fazio and Melville (2008; 193-209) is aimed at teacher development. When NCS was introduced in South Africa, teachers were not trained or developed in general and particularly in the Natural Sciences, where understanding of scientific inquiry and the Nature of Science is of paramount importance. Inquiry as a teaching strategy tends to replicate a constructivist method of knowledge imparting.

Fazio and Melville (2008) maintained that within science educational contexts, the nature of science could be concisely explained as the epistemology of scientific information and the progression by which grows. I argue educators should retain opinion (ideas and information) that are corresponding with these change aims if they are to transfer their perspective into correct prospectus skill for learners.

However, it seems that Fazio and Melville (2008) have identified that many teachers did not have the prospect during their high and tertiary science skill to study the theoretical subject matter information essential to prepare them to learn scientific research and the natural science successfully. Academics like Alsop, Bencze, and Bowen (2006), De Haan (2005), Jeanpierre, Oberhauser and freeman (2005), as quoted by Fazio and Melville (2008), agree on this issue.

According to Irez (2006:1114) educatorsô conception regarding NOS (nature of science) was inadequate. During the study when answering the question ñAre we prepared?ò the finding showed that educators are not prepared because of inadequate conceptions regarding NOS. Research conducted by Lumpe, Haney and Czerniak (2000) has shown that the beliefs and knowledge of teachers are not necessarily consistent with the curriculum reform efforts and the same applies to South African teachers with the implementation of the NCS (Fazio and Melville, 2008).

The teachers should be developed personally, socially and professionally through frequent workshops and over an extended period. According to Fazio and Melville (2008:203), individual advancement concerned participation in the creation, assessment and acknowledgement of information is created from cooperative gatherings, recitals and practice. It must never be thought that operational curriculums have been executed in preliminary educator curriculums, nor must it be thought that specialised in-service models, usual in school regions, are adequate to sort it out with personal and long-standing progressive wants suitable for operative educator learning.

The South Africa educators are like the new beginners teachers who need development programs to empower them. In Luftọs study (2007), the findings revealed that beginning science teachers differ from their pre-service and in-service counterparts and deserve some undivided attention. Curriculum 2005 could have been implemented better if the implementation plan was properly done. According to Onwu and Mogari (2004), academic enhancement is one of South Africaọs aims in the on-going improvement of its curriculum system.

Endeavour UNIVEMALASHI, a region-level organised improvement proposal for educator advancement, has been up-and-coming in refining the subject matter, ability and feeling of an example of 110 partakers in the Foundation Phase (6-9 years) and educators for the duration of the 1st three classes of its put into operation.

The strategies which were successfully used by the researchers (Onwu and Mogari, 2004) are as follows:

1. Workshop to change the educatorọs mind set.
2. Visit by district ECD specialist to assist and support educators.
3. Cluster meetings, conducted by specialist on weekly basis assisted the participants to understand curriculum 2005 better in the UNIVEMALASHI project.
4. School-based workshop is necessary to compliment and to work collaboratively within small groups to assist and support each other.
5. Parental involvement is vital to assist learners with their homework, career path and to monitor their children`s academic progress.

Even in the South African context, for educators to interpret and integrate learning outcomes, especially scientific inquiry, modernized, prolonged pre-service science and job-related science educator improvement curriculums are needed to tackle equally the views and information conditions of educators, alongside with circumstantial truths of schools, in turn to improve hands-on concepts (Calmer & Daly, 2004).

Another way frontward is to uphold educator and prospectus advancement by way of partaking in concerted action research even at school, circuit and provincial level, and this argument is presented in the following section in the Theoretical Framework designed for this study.

2.8 THEORETICAL FRAMEWORK

Flinders and Mills (in Anfara and Mertz 2006: xiv) argue that: ñPrecise definitions [of theory] are hard to come byò but philosophy has been described in different ways by academics of science and scientists in the scholastic. To comprehend a hypothesis is to tour someone elseǿs intellect and turn out to be able to realise the truths as that individual does. To perceive theory ñone needs to stretch oneǿs mind to reach the theoristǿs meaningò (Silver, stated in Anfara & Mertz, 2006: xv). According to Reichel and Ramey (in Smyth, 2004:3) a theoretical framework is: ñA set of broad ideas and principles taken from relevant fields of enquiry and used to structure a subsequent presentationò.

In turn, to perceive the complication of the application and the framework in which teachers were operating, as the investigator, I started to investigate how educator`s interpret NCS policy, namely how to integrate assessment standards when conducting scientific investigations in Natural Sciences in the Intermediate Phase.

Having started formation of my information from the groups of collected works around modern Scientific Investigation hypothesising and metaphysical dialogue, I wanted a controller as explained by Smyth (2004). Smyth (2004:2) stated that theoretical maps give some help but offer inadequate framework for the intention, so a condition was established contrasting (put things side by side often for contrast) major topics from collected work revised and Habermasian theory. This was meaningful stride which helped in arranging my reasoning, facilitated meaning-making of the data and provided a structure approach to communicate the findings (Smyth, 2004).

According to Smyth (2004:1), the directing ideology of the theoretical framework must be reliable with the policy reinforcing the report since these are essentially resulting from constructivist theories suitable to research in the get-together world of schooling. Correspondence must be overtly founded between the ways of researching the location (methodology) natural surroundings of the circumstances truths (ontology) and type of the information (the epistemology) suitable to the investigation.

Kerlinger (in Anfara and Mertz 2006: xiv) defined theory as:

> *"a set of interrelated constructs, definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting phenomenon".*

Researchers utilise a group of intentions that are systematically similar. It is the connection of intentions that composes a philosophy. When we develop theory, we have accomplished an extremely conceptual thought procedure with views being detached in continuous phases from the world of instant know-how and sensation. Although abstract, philosophies are intensely useful for appreciating the knowledgeable world (Anfara & Mertz, 2007).

Errant (in Della 1995:66) has the following to say about theory:

> *"Yet people use theory all the time, and it is their personal theories which determine how they interpret the world and their encounters with people and situations within it".*

Drawing on Smyth (2004), Anfara and Mertz as well as the review of the literature, the theoretical framework, designed for this study, was theoretically associated with the approach and epistemology transporting the study so it gave a proper spine for the dissertation, in line with the far-reaching goals of the investigation and is depicted in Figure 2.1.

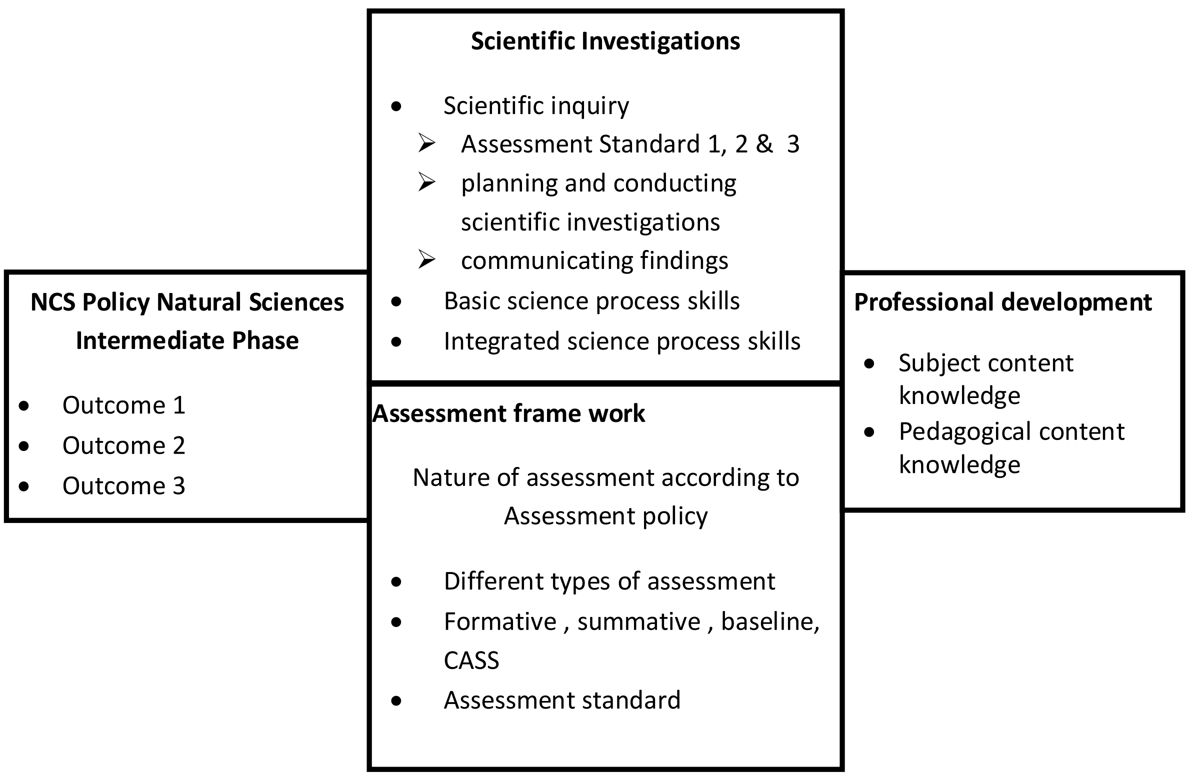

Figure 2.1: Implementation theory and educators' practice: combined theories in Mutereko (2009:28)

The major variables within the field in which the problem is situated is the NCS policy interpretation, integration of assessment standards when conducting scientific investigations, assessment framework involved, amongst which are assessment strategies, relevant assessment tools and lastly, the emergent need for professional development to resolve the problem at hand. To me as the researcher, the above represent the overarching view of how the variables interact. I adopted an anti-positivist/subjectivist stance, seeing the world of phenomena as softer, personal and created by a human which is the qualitative approach. My aim was to build up an implicit theory in my mind. When observing, interviewing, analysing the data from the sample of participants, this theoretical understanding would provide me with a lens to undertake this investigation or systematic research following a narrative analysis.

The NCS policy in Natural Sciences informs educators on how to conduct LO 1: Scientific Investigations (DoE, 2002). The NCS policy goes further to show how assessment standards are to be integrated and the assessment framework within which educators should assess their learners.

The last rectangle shows the importance of professional development needed to assist educators become better policy implementers. This investigation is meant to prove my hypothesis that many educators teaching Natural Sciences in the Intermediate Phase have little understanding of NCS policy and are challenged to implement it successfully, particular LO 1: Scientific Investigations. The observations and interviews to be conducted give evidence to my theory.

2.9 CONCLUSION

The second chapter was a review of relevant sources in this investigation and addressed the following: Scientific investigations and the assessment standards involved (which is the main focus), scientific literacy, various ways of classifying classroom inquiries including experiment, the assessment framework as stipulated by NCS policy and the educator development as well. The final section presented the theoretical framework designed for this study.

The next chapter, Chapter 3, deals with research strategies used to collect data and the methodology followed in this investigation.

CHAPTER 3
DISCUSSION OF THE RESEARCH METHODOLOGY AND DATA COLLECTION THAT APPLIED TO THIS INVESTIGATION

3.1 INTRODUCTION

This chapter focuses on the research methodology followed in this research which seeks to answer the research question: *How do educators interpret and integrate the assessment standards when conducting scientific investigations in the Intermediate Phase?* The research methodology is discussed to provide the reader with reasons why these have been considered appropriate for the study. As research methodology vary, only those that have been followed in this investigation are discussed.

A qualitative approach, with a number of data collection method was followed in this research and is discussed in Section 3.2. In Section 3.3 the sampling for this study is presented while in Section 3.4, the data collection plan is presented and discussions are entered into with regard to criteria used to assess teacher opinion, validation of the measuring instrument, and method followed to enhance validity.

3.2 QUALITATIVE RESEARCH DESIGN APPLIED DURING THE INVESTIGATION

In qualitative research, philosophies are classically not verified. Alternatively, the researcher requests contestants in a report, to impart views and construct broad topics founded on those views (Lacey, 2009).

In this study, a variety of qualitative methods have been followed during the data collection process namely the observations, interviews and document analysis. Participants in this study have been limited and the results and conclusion have not been based on numbers, but on educatorsô opinions about their understanding of scientific investigations and the integration of assessment standards within this Learning Outcome (LO 1) which deals with Scientific Investigations.

Denzin and Lincoln (in Barrett 2007:417)

> ñ*characterise the interpretative origin of qualitative research by defining that qualitative inquiry is located task that sets the viewer in the world. It consists of a group of interpretative, resources put into practise that create the world visible.”*

When collecting data I tried to internalise educatorsô understanding of Scientific Investigation as a phenomenon. During observations as the researcher I will establish how they teach and assess learners.

According to Graue and Walsh (in Barret 2007) the first renovations include making illustrations of the remarkable world through data production, which is a lively, artistic, improvisional progression. After collecting data, the analysis was based on the educatorsô views on scientific investigations and the integration of assessment standards during the investigations. This implies that the interpretations about educators are based on the opinions these educators gave during interviews.

3.2.1 Interviews as a Qualitative Data Gathering Strategy

According to Barret (2007:418) during field notes taking, the investigator directs observations and interviews and collects brochures and pieces of objects that brighten the incident under study. As the researcher in this investigation, I interviewed educators and observed them in practice to determine their understanding of the NCS policy and analysed how they integrate assessment standards when conducting scientific investigations. Tuckman (in Ramoroka 2006) argues that happenings cannot be comprehended except one perceives how these happenings are understood and translated by people who took part in them.

Thus, this investigation focused only on educators teaching Natural Sciences in the Intermediate Phase (Grade 4-6). Thirteen educators were purposefully and conveniently sampled, because all of them were working within the Mankweng cluster in close proximity to where I work and live.

According to McMillan and Schumacher (2001:251), from the interview steers methodology, themes are chosen beforehand but the inquirer resolves the order and phrasing of the interview direct tactic and is moderately spoken and situational. It was vital to collect information while educators were busy implementing NCS policy in Natural Sciences, conducting scientific investigation and the integrating assessment standards. An interview is often characterised as a conversation with a goal. The interviewee can figure the subject matter of the interview by concentrating on issues of significant or fascination (McMillan and Schumacher, 2001).

According to Tuckman, (in Ramoroka 2006) another means to reveal about an incident is to request questions of the persons, who are participating in it in some particular way, particularly as ñthe purpose of interview is to find out what is in or on someoneøs mindò (Patton in Ramoroka 2006:50). This has led to interviews as one of the data collection strategies followed during this investigation. Interviews were important because each educatorøs answers reflected his or her perceptions and understanding of scientific investigations and the integration of assessment standards.

Patton (in Ramoroka 2006) farthest contends that people are interviewed in turn to decide from them those features which cannot be straight experiential as everything cannot be perceived. In this research, educatorsô opinions have been probed during the interviews. Dexter (in Briggs and Coleman, 2007:207) explains the interview as follows: ñConversation with a purposeò, trying to find out what is in somebody elseøs mind but not put things there. Briggs and Colemanøs view (2007:208) is that: ñWe interview people to explore their views in ways that cannot be achieved by other forms of research and report our findings in as near as we reasonably can their own words.ò

Guba and Lincoln (in Briggs and Coleman, 2007:207) explain that:

> *"Of all the means of exchanging information and gathering data known to man….interviewing is perhaps the oldest and certainly one of the most respected of the tools that the inquirer can use".*

Thus, interviewing is the favoured approach of collecting data mainly when ñIt seems that it will get good data or additional data at fewer costs than approachò (Dexter, in Briggs and Coleman, 2007:207). According to Cohen, Manion and Morrison (2000:267) interviews afford partakers (interviewer and interviewee) to debate their understandings of the world in which they locate, and how they consider circumstances from their personal point view.

In this research, I tried to find of what teachers think about conducting scientific investigation and integrating assessment standards, and it was considered that this could be carried out during interviews. The other vital aspect is interview management, which is producing rich and reliable data from interview-based research and requires managing effectively at least four key aspects: what is asked and how, the interviewer and interviewee, recording and transcribing (Briggs & Coleman, 2007).

Interviews were conducted to gather information about educatorsô understanding of scientific investigations; integrating assessment standard and using the relevant tools to assess learner projects (see Annexure A). When conducting interviews some of the questions were planned prior to the interviews. Some questions were drawn from educatorsô responses. Questions that were planned prior to the interviews guided the investigation, but they did not restrict educatorsô opinions. The educators were expected to give their opinions with regard to their understanding of conducting a scientific investigation and how to integrate the assessment standard during lesson presentation and assessment thereof.

3.2.2 Classroom Observations

Classroom observations were conducted in addition to the interviews to determine whether the educatorsô opinionsô corresponded with their practices. This reinforces Marshall and Rossmanôs (in Ramoroka, 2006:51) argument that if interviews are merged with observation, they permit the researcher to comprehend the significances people embrace for daily tasks. Classroom observations aided in determining whether educators were able to teach learners how to conduct scientific investigations and integrating the assessment standards using relevant assessment tools and assessment strategies as well. Direct classroom observations were helpful to determine how educators taught and assessed their learners in the classroom which meant sitting in the classroom in an unobtrusive manner as possible and watching educators deliver a programme to students (Tuckman in Ramoroka, 2006:50). This researcher states that what should be observed is the event or phenomenon in action (Tuckman in Ramoroka, 2006:50). Cohen et al. (2000:109) state that: ñBecause observed incidents are less predictable, there is certain freshness to this form of data collectionò.

According to Robson (in Briggs and Coleman 2007:207), observation is sometimes part of ethnographic inquiry and spearheads to a depiction of people, happenings and or beliefs. It is therefore an all-inclusive method regarding the observation of daily happenings and the explanation and formation of purporting, rather than generation of happenings (Briggs & Coleman, 2007). Another type of observation is qualitative field observations which are detailed descriptions of events, people, actions, and objects in setting. Classroom observation is used in interactive data collection, such as participant observation and interviewing. The researcher relies on careful observation, explores several areas of interest at site, selecting and searching for patterns of behaviour and relationships (McMillan & Schumacher, 2001).

Classroom observations were planned in order to confirm or disprove the researcherôs interpretation of their opinions expressed in the interviews. Observations were extremely useful providing me with information educators might not have supplied during interviews and for validating or refuting the discussions. The checklist for classroom observation is included as annexure (see Annexure B)

3.2.3 Document Analysis

Document analysis is a type of qualitative study that needs scholars to trace, translate and lure inferences about the testimony offered. Documents are required to be examined and interrogated in the context of other sources of data (Briggs & Coleman, 2007). Laborious strategy of a condemnation is useful to documents to establish genuineness. Marshall and Rossman (in Ramoroka, 2006:51) argued that academics complement contestantsô observations, interviewing and observation with collection of documents in the direction of daily happenings

In this research, educatorôs files were reviewed to determine how educators record the marks obtained by learners after a scientific investigation was conducted. Because LO 1 (Scientific Investigation) have three (3) assessment standards as planning a scientific investigation, conducting scientific investigation, collecting data and evaluate data and communicate findings, as the researcher, I expected to find an analytic rubric with marks allocated to show how learners perform and progress to the next grade and support the learners if need arises. In the educators files there were marks for tests and assignments which tested the learnerôs memory only but no projects, experiments or practical tests were recorded. The lesson plans found did not show how to implement the assessment standard eluded above.

Documents reviewed were classroom assessments, evidence such as rubrics for project assessment, formal tasks, mark sheets, test schedules, continuous assessment (CASS) and portfolios for both educators and learners. The purpose of this document analysis was to determine how educatorsô interpret the NCS policy for Natural Sciences when conducting scientific investigations; how they integrated the assessment standards and the influence it has on the actual classroom practices. In addition, document analysis was conducted to check their planned assessment, method of assessment, assessment strategies and assessment tools (see Annexure C).

3.3 SAMPLING PROCEDURES FOLLOWED DURING THE INVESTIGATION

Purposive, convenience and sampling was followed in this investigation. According to McMillan and Schumacher (2001) in focused sampling, the samples are selected because these contestants are probable to be well-informed and instructive about the occurrences the investigator is researching. The teachers implicated in this research were teaching Natural Sciences in the Intermediate Phase. The second type of sampling was convenience sampling which involved choosing the nearest individuals to serve as participants Cohen, Manion and Morrison (2000:102). The sampling methods were the most suitable in this investigation because for the researcher it was a way of reaching participants in this investigation who could add the most value with their input. According to Cohen, Manion and Morrison (2000:98) ñResearchers need to ensure that not only access is permitted, but is, in fact, practicable. The sampling strategy followed is purposeful as participants are educators who are busy with their day to day teachingò.

The participants sampled for this study had attended briefings on LO 2 (Constructing Knowledge) and LO 3 (Society and Environment) which were aimed at informing and equipping them with knowledge and skills to implement NCS policy for Natural Sciences but nothing was done regarding how to conduct a scientific investigation. The study took place in the Mankweng area in the Capricorn district in Limpopo province. Mankweng area is divided into five circuits and each was represented. This area was chosen as the researcher works and lives there. Thirteen (13) primary school educators from six different schools took part in this study. Two educators per school in four schools and three educators per school in two schools were chosen. Initially, the participants were fourteen before one educator decides to withdraw. In schools where two educators were chosen, network sampling was followed. One participant was asked to refer the researcher to another educator who could be willing to take part in the investigation. As educators work together, they know each other better than the researcher does. To explore educatorsô understanding of the NCS policy for Natural Sciences LO 1: Scientific Investigations, integrating assessment standards and assessment. Most educatorsô involved in the study were teaching in schools located closely to where I live or where I teach, therefore both convenient and purposeful sampling were applied. This was done to minimise costs and problems when arranging meetings with them.

Educatorsô understanding of NCS policy for Natural Sciences LO 1: Scientific Investigations in the Intermediate Phase was the focus of the investigation.

3.4 DATA COLLECTION AND DATA ANALYSIS

3.4.1 Introduction

This section focuses on criteria to be used to assess teachersô opinions regarding the integration of assessment standard when conducting scientific investigations, coding, categorisation and classification of data, validation of the measuring instrument (interview schedule), methods followed to enhance validity and as well as methods to enhance reflexivity.

3.4.2 Criteria used to Assess Teachers' Opinions regarding the Integration of Assessment Standard when conducting Scientific Investigations

During the interviews, educators were asked a number of questions involving their understanding of the NCS policy and its application to their teaching. (See Interview Schedule Annexure C). Their responses to the questions should meet the following requirements to support their understanding of NCS policy for Natural Sciences (LO 1) that refers specifically to the use of Scientific Investigations in the Intermediate Phase (Gr 4-6).

- planning for scientific investigations and how to teach that planning to learners
- Suitable place and time to conduct scientific investigations
- Data collection and sources readily available to both educators and learners
- The teaching of data evaluation
- Communicating the findings of scientific investigations

3.4.3 Coding, Categorisation and Classification of Data

This sub-section focuses on the way collected data were categorised and coded. Lofland and Lofland in Dudwick, Kuehnast, Jones and Woolcock (2006:36) conclude that:

> *"Through this process ...some codes begin to assume the states of overarching ideas or propositions that will occupy a prominent or central place in the analysis"*

According to McMillan and Schumacher (in Ramoroka 2006:53), when coding, data should be grouped into topics. Data are divided into parts through classification system. A number of themes were covered when planning questions to be asked during interviews. Patton (in Ramoroka, 2006:53) states that the following themes can be covered during interviews:

- *Experience/behaviour questions*: these are questions that deal with what the person does or has done.
- *Knowledge questions*: asked to find out what factual information the respondent has.
- *Sensory question*: questions about what is seen, heard, touched, tasted and smelled.
- *Background knowledge*: these identify characteristics of the interviewee.

These above-mentioned themes helped me come up with the criteria outline in Section 3.4.2 above. For the researcher to receive enough information during interviews, questions covered a number of aspects. This was an aid when planning questions before the interviews were held. Tuckman (in Ramoroka 2006:54) argues that in selecting questions, one should not ask only about intentions, but about what actually occurs. The variables to be measured are important towards the designing of good questions. In this investigation, the following variables were measured:

- educatorsô understanding of the NCS policy for Natural Sciences,
- application of assessment standards when conducting scientific investigations,
- how they design lesson plan, and
- Implementing (teaching) NS in the Intermediate Phase.

Some questions asked covered educatorsô knowledge and opinion on the interpretation of the NCS policy for Natural Sciences when conducting scientific investigations and assessment practice in classroom. Other questions related to their behaviour and feelings on the NCS policy for Natural Sciences particularly LO 1: Scientific Investigations and these were reflected in their classroom practices.

Data were divided into parts and grouped under the themes which included the following:

- Planning for scientific investigations and how to teach that planning to learners,
- suitable place and time to conduct scientific investigations,
- data collection and sources readily available to both educators and learners,
- the teaching of data evaluation,
- communicating the findings of a scientific investigations, and
- Assessment practices and record-keeping (DoE, 2002).

According to Dudwick et al. (2006:35) study of qualitative data is chiefly and inductive, as differed to a deductive process, implying that the investigator attempts to detect arrangement in the data rather than officially assessing the occurrences. This is known as a ñthick descriptionò increasing a list of propositions, or the creation of a typology showing how one group of variables is connected each other. The researcher, in this study endeavoured to discern patterns in the data rather than testing a theory.

Krisna (in Dudwick et al.2006:36) emphases that the study would subsequently acquire an amalgamated structure to indicate how the best noticeable variable were connected to each other although Dudwick et al. (2006) state that the study of qualitative data should support all-purpose ideologies, slightly than go along with stiff practical set of laws. It is vital to recall that what might look obvious once a study is concluded was generally unidentified or darken before a study start. Noble qualitative investigation is in numerous regards the skill and science of crafting clear some procedures (and the relation between them) that are commonly buried or unknown. In this study, I was determined to prove to the educators, principals, curriculum advisors and policy makers that scientific investigation, as a learning outcome has it challenges and at present is not being taught effectively, thus compromising the learning of Natural Sciences in the Intermediate Phase which does not adequately prepare learners for the next phase of schooling.

Dudwick et al. (2006) shows that qualitative data is regularly composed consecutively, with an original ring-shaped of research providing increase to afresh topics, quest, and procedures, significance that the data prepared itself is regularly a in-service procedure. The foremost step is to code the data, that is, categorise it limited to numeral categories (emerging from data). The categories ultimately developed the major variables used up to discuss resemblances and differences within the data. Lofland and Lofland in Dudwick et al. (2006) commended that investigation uphold four various kinds of codes: housework (daily notes on happenings, people, and associations in the site analysis), rational (emerging themes from data, as well as one items many ways), information-gathering (collecting data procedures pertaining and initial probe) and sequential (systematic line in which happenings followed). As the study evolves ñcategories inside the nominated codes are expanded. Other codes are distorted and still others decrease.

3.4.4 Validation of the Measuring Instrument (Interview Schedule)

According to McMillan and Schumacher (2001:407), validity tackles the succeeding questions: Do the inquirer truly gets what they imagine seeing? Do the investigators truly get the senses those meanings that they believe they perceive? These researchers contended that validity of qualitative designs is the gradation to which the clarifications and theories have related reasons between the participants and the investigator. When the instrument for qualitative data collection is developed, the researcher should ensure that what he/she wishes to observe is clearly understood. The researcher should also ensure that the questions prepared are clearly understood so that participants give him/her information that is relevant in the investigation.

To ensure common understanding of words used in the instrument content validity has to be addressed in this investigation. Cohen, Manion and Morrison (2000:109) argue that to make sure that content validity is valid; the tool should display that it objectively and meticulously shields the territory or things that it intends to shelter.

To make sure that this occurred, questions that could reflect educatorsô understanding and how such understanding impacts on their assessment practices were asked. The literature study was used to validate the instrument. The articles reviewed and books read have been helpful to ensure that content validity is addressed in this investigation. Multiple method strategies have also been followed to enhance validity in this investigation. McMillan and Schumacher (2001:8) argue that most interactive researchers employ several data collection techniques in a study, but one is usually selected as the central technique used. Although interviews were seen as the central technique, observations and document analysis have been conducted to supplement the interviews.

Time as well as venues had to be convenient for the interviewer and interviewees in order to avoid disturbances during the interview process. The use of a video recorder allowed the interview process to proceed without having to ask the respondents to repeat any information and to ensure that no information was lost.

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The following table, Table 3.1, presents the validation of the instrument used for data collection when interviewing the educators.

Table 3.1: Validation of the instrument

Questions	Sources of reference where the questions were taken from:
What is a focus question on Scientific Investigations?	Ferrance (2000:10); Fuchs (2005:49)
How do you plan an investigation and how to teach planning the inquiry?	Department of Education (2002:25)
How do you lead a scientific inquiry and how to you go about data collection?	Sardharwalla (2006); Schwab (in Trumbull et al. 2005:880); De Boer (in Trumbull, 2005)
How do you evaluate data and how do you communicate findings?	Ferrance (2000); Conana (2009:55)
Which assessment strategies do you follow when conducting Scientific Investigations? Which tools and forms of assessment are relevant to scientific investigation?	Department of Education (2002:22)
Which records are kept by the educator and used to evaluate learner`s performance/progression?	Siebörger(in Ramoroka, 2006:56)

3.4.5 Methods Followed to Enhance Validity

According to McMillan and Schumacher (2010) hereunder follows the important strategies to enhance validity. Included in this description is a presentation of what was done in this study to ensure validity:

1. *Prolonged and persistent fieldwork*: Participant observation and in-depth interviews were conducted in a natural setting (classroom) to reflect lived experience. The lengthy data collection provided me as the researcher with the prospects for provisional data analyses, introductory likenesses, and verification to improve views

and to confirm the complement between evidence-based categories and contestantôs truths.

2. *Multiple methods*: Participant observation, open observation, interviewing and document analysis are an interwoven web of technique used in this investigation. Multi-method methods permit triangulation (obtaining convergent data using cross-validation) of data inquiry techniques. The use of different methods, such as interviewing, observation and document analysis yielded different insights to increase the credibility of the findings.
3. *Participant language and verbatim accounts*: Questions posed were written in a familiar language relevant to educators and were repeated sometimes when the researcher was requested to do so.
4. *Mechanically recorded data*: Videotapes was used because it provides accurate and relatively complete record. No situational aspect that could have affected the data recording, hence it was usable.
5. *Participant researcher*: In order to corroborate what has been observed and recorded, interpretations of participantsô meanings, and explanations of overall process were observed as well, for example, projects, diaries and daily journals.
6. *Participant review*: Transcript review was done only with participants whose data was inaccurate, as well as to modify data before is analysed for comprehensive integration of findings.
7. *Negative and/or discrepant data*: Negative cases emerged from participantsô response where they were not answering the question asked. Those responses which had nothing to do with the questions were coded as such.

McMillan and Schumacher (2010) identified the following methods to enhance reflexivity. In this section, this is a presentation of what was done in this study to enhance reflexivity:

1. *Field log/visiting schedule*: My field log provides a chronological record by date and time spent in the field, including getting access to sites and participants. It also contains the entry, the places and person involved are attached as annexure B.
2. *Reflex journal/personal diary*: I used a personal diary to record continuously the conclusions formulated through the emergent strategy and justification.
3. I used the diary again during the adjustments of the research question and tactics.. The assessment of the trustworthiness of each data set was done in the personal diary.

Lastly, I used the personal diary to trace the ideas and personal reactions throughout the fieldwork.

4. *Audibility*: is seen as the practice of maintaining an evidence for data controlling tactic for and determination policies that document the sequence of proof or judgement track.
5. Audibility in this case includes the codes, categories, and themes used in description and interpretation as well as drafts and preliminary diagrams. The chain of evidence below will be available for inspection and confirmation by outside viewers.
6. *Formal corroboration of the initial findings*: The focus group in this investigation was educators teaching Natural Sciences in the Intermediate Phase (Gr 4-6). The interviews were conducted with 13 participants. They were also observed during their classroom practice and their documents were analysed as well. As a corroboration activity, the data were completely analysed. The confirmation activities by the examiner would ensure that the pattern found have not been unduly contaminated by the researcher.

3.4.6 Implementation Schedule

Before data were collected, a pilot study was conducted in August 2011 with one interviewee per day for five days. Only five participants were involved in the pilot study. This was done to validate the interview schedule to enable the researcher think about what to expect from educatorsô responses about the interpretation of the NCS policy and the integration of assessment standards when conducting scientific investigations. To gather the intervieweesô opinion about scientific investigation meaning that some of the concepts had to be explained first. Each interviewee had to be present for one interview during the pilot study. The information supplied by the interviewees was not sufficient therefore the number of the participants had to be increased. Findings from the pilot study alerted me to the fact that most participants were not aware of how to conduct scientific investigations and to integrate assessment standards for NCS policy for Natural sciences. This prompted me to reformat the instrument in order to write the report. The interview time was restricted due to unforeseen circumstances and this is attributed to lack of information.

After I was satisfied that the instrument was valid, an arrangement was made for the interviews to be conducted in the full study. Appointments were made with the educators to proceed during weekends and after hours as well.

Both interviews and classroom observations were arranged so as not to disturb the smooth running of the schools. During both interviews and classroom observations a video recorder was used to capture all the information supplied. After the lessons were observed, they were transcribed into text so that data analysis could be done easily. (Refer to Annexure B). Permission was requested from participants before the video camera was used. After the permission was granted by the participants, a brief introduction and aim of the investigation was made known to the participants.

In preparation for the interviews, participants were told to ask questions when clarity was needed. They were told that the information collected was strictly confidential and private. Interview questions were planned in such a way that the criteria given in Section 3.4.2 were covered and valid inferences could be drawn from educatorsôresponses.

The tables below summarise the plan for interviews:

Table 3.2: The summary of criteria used during the interviews

Criteria	Follow up questions	Objectives
Educators understanding of the Scientific Investigations	Questions to be asked during interviews.	What is to be achieved?
How much time is allocated for Natural Sciences In the Intermediate Phase?	How best can the allocated time be spread amongst the three learning outcomes?	To determine whether the time allocated has an impact on the conduction of Scientific Inquiry?
How many strands are there in the RNCS policy Natural Sciences in the Intermediate Phase?	How can educator plan, prepare and conduct the scientific investigation in each strand quarterly?	To determine whether the educator can plan prepare organise the work well and complete it in record time.

Table 3.3: Summary of the questions planned prior to the interviews.

What was to be known?	Main question to be asked	Possible probing questions	What was to be achieved with the answer?
Focus question on Scientific Investigations	In your opinion, what is a focus question when conducting Scientific/focus knowledge/Investi gation?	How do you ensure that the question is not answered by "yes" or "no", but is researchable?	To determine what educators know about "good research question"
Planning an investigation	How do you plan an investigation and how do you teach the planning?	How do you plan a clear and concise plan?	To determine whether educators can plan properly and assist learners as well.
Conducting an investigation	Where and when to conduct a Scientific Investigation?	How long can it take learners in the Intermediate Phase to conduct a Scientific Investigation? week/month/year	To determine whether when conducting the investigation is according to plan and procedures.
Collection of data	Which sources of data are readily available to educators and learners?	Where and how to collect data?	To find out whether the educator knows strategies used to collect data e.g. observation, interview.
Evaluation of data	How do you evaluate data	How do you teach learners to analyse data, what do you do with the inconsistent data?	To determine whether educators understand analysis of data
Communicating findings	How do you communicate the findings?	With whom do you communicate the findings?	To determine whether the educator knows the importance of communicating findings

The following criteria were used during observations of the lessons concerned with LO 1| Scientific Investigations:

- Number of learners in a classroom
- Classroom setting
- The use of resources
- Teaching methods followed
- Assessment methods followed
- Learner participation
- Incorporation of assessment standards when conducting scientific investigation

During document analysis, the following criteria guided the analysis:

Table 3.4: Summary of criteria to be followed when the documents are to be analysed

What to look for?	What is to be achieved?
1. Which documents are kept by the educator in the Natural Sciences file?	1. To determine whether the educator keeps all the relevant RNCS policies for Natural Sciences?
2. How many lessons designed and assessments on Scientific Investigation are there on each of the strands per term/quarter?	2. To determine whether the lesson designed and assessment plans in the file are sufficiently done to achieve the Scientific Investigation (LO1).
3. When designing the lesson plan, does the educator explicitly show the integration of the assessment standards when conducting Scientific Investigation?	3. To determine whether the educator understands the steps to be followed when conducting Scientific Investigation (LO1) or qualitative research.
4. Are there any records/projects done by learners previously to assess the educator`s understanding of Scientific Investigation (LO1)?	4. To determine the educators` output / implementation of the Scientific Investigation within the parameters of the school.
5. Which records kept by the educator are used to evaluate learners `performance/progression?	5. To determine whether the records kept have adequate information to be used to evaluate the learners' performance/progression.

The following criteria were followed when the documents were analysed

- The assessment records kept by educators
- Record keeping and checking of those records kept.
- The purpose of those records must be clear.
- Those records should be helpful to both the educators and learners.
- The records should reflect the educatorsô understanding of NCS policy for Natural Sciences (LO 1) Scientific Investigations.
- Learnersô performances should be evaluated using the records that are kept.

In addition to the interviews, observations of educators were conducted in five schools. Before observations for educators in practice could start, the aim of the observations was discussed. This was necessary to make educators feel comfortable and at ease during the researchersô presence in classrooms. After the observations were conducted, educators were asked to provide the researcher with the documents used to keep records of their classroom activities. These documents included books, files, portfolios and learnersô books (The records they provided were evaluated against criteria shown above).

3.5 ETHICAL CONSIDERATIONS

In the terms of quality of the research, the researcher paid attention to Goodson and Mangan`s views (in Saka, 2007) on epistemological and ethical implications in qualitative research. According to Marshall and Rossman (in Saka, 2007) efficiency and ethical considerations are the most significant quality criteria for a qualitative research.

Receiving approval from Department of Education in Limpopo (see Annexure D) to access the activity systems of each participant which was coupled with permission to visit schools (see Annexure F). The researcher further received the permission from Ethics committee of the University of Pretoria (see Annexure E) which was another facet of ensuring the ethical soundness of this study. The participants were informed about the research through the letters and they accepted the request by signing the consent form (see Annexure G)

3.6 CONCLUSION

This chapter dealt with the research methods followed in this investigation. The sampling procedures and data collection plan has been discussed. Validation of the instrument used during interviews and implementation schedule has been dealt with in this chapter. In addition to the interviews, observations were conducted and documents were analysed.

The next chapter, Chapter 4, deals with data analysis and reporting the results of the investigation.

CHAPTER 4
REPORTING THE RESULTS OF THE INVESTIGATION

4.1 INTRODUCTION

The aim of this chapter is to provide the reader with the results of the investigation and a brief discussion. The reader will read about the (a) interviews, (b) classroom observations and (c) document analysis. Interview questions were posed by the researcher, responses by participants in tables and a brief discussion below every table. The summaries of tables are classified in two (2) columns. Lastly, the reader will read the observation check list used by the researcher against the findings during lesson presentation in the classroom and as well as the findings on the participantŝ files for Natural Sciences (NS) in the Intermediate Phase (IP).

The table below contains the symbols and their explanations which have been used frequently in this chapter.

Table 4.1: Symbols used in this chapter

Symbols	Explanation
[[[ ]]]	The square brackets are used to indicate that the response by the participant is not answering the question asked by the researcher
P	Participant.
PP	Indicate that the same participant recorded already is giving the second different answer e.g. PP8 (participant eight) in Table 4.7
PPP	Indicate that the same participant recorded already is giving the third different answer e.g. PPP 8 (participant eight) in Table 4.7
PPPP	Indicate that the same participant recorded already is giving the fourth different answer e.g. PPP8 (participant eight) in Table 4.7
0 (zero frequency)	Occur because the PP; PPP; PPPP cannot be counted again because they are repeating themselves in the different category but on the same table.
……..	Indicate an incomplete comment (1st comment in Table 4.5)
NS	Natural Sciences
IP	Intermediate Phase

4.2 BIOGRAPHIC INFORMATION OF THE PARTICIPANTS

Table 4.2 below depicts the participants who participated in this study. All the participants have not been trained on how to conduct a scientific investigation. There are six (6) male participants and seven (7) female participants. According to the reports I got from them they do not know how to conduct scientific investigations.

Table 4.2: Background knowledge check

Prospective educator	Gender	Field of specialisation at college	Grade/ level	Prior research experiences on scientific investigation
P1	F	ACE in Techno-logy and Natural Sciences	4	None
P2	F	Biology	6	None
P3	F	Biology	4	None
P4	M	History	6	None
P5	F	Biology	4	None
P6	M	Biology	5	None
P7	M	Afrikaans	4	None
P8	F	Maths & P.Sc	6	None
P9	F	Biology	6	None
P10	M	Biology	5	None
P11	F	Biology	4	None
P12	M	Biology & P.Sc	6	None
P13	M	Biology & Tech	5	None

(Adopted from Crawford, 2000: 8)

4.3 INTERVIEWS WITH THE PARTICIPANTS

This section focuses on reporting the interviews conducted with participants in this study following the themes of policy interpretations (4.3.1), the integration of assessment standards (4.3.2) and assessment for learner progression (4.3.3).

4.3.1 Policy Interpretation

The interview questions below are based on **policy interpretation** (NCS policy) and subsequently the sub-question presented in Chapter 1 was used as a frame of reference for the interview questions dealt with below: *How do the NCS and the assessment policy informs educators on how to conduct scientific investigations in the Intermediate Phase?*

1. *How much time is allocated for Natural Sciences in the Intermediate Phase?*

Table 4.3: Time allocated for teaching of Natural Sciences in the Intermediate Phase

	Time allocated	Participants	Frequency
1	Six periods, 3hours 30 minutes (TA 1)	P1	1
2	3hours 30 minutes (TA 2)	P2, P3, P7, P8, P9, P10, P13	7
3	Three hours per week (TA 3)	P4	1
4	Seven hours (TA 4)	P5, P6	1
5	7 hours 30 minutes (TA 5)	P11	1
6	Seven periods per week (TA 6)	P12	1

As illustrated in Table 4.3. above, seven participants (P2, P3, P7, P8, P9, P10, P13) out of 13 responded by saying that the time allocated for Natural Sciences in the Intermediate Phase is 3 hours 30 minutes. P1 stated that 6 periods which is 3 hours 30 minutes is allocated while P5 and P6 responded that time allocated is seven (7 hours). Participant P11 responded that time allocated for teaching Natural Sciences is 7 hours 30 minutes. Participant P12 responded that time allocated for Natural Sciences teaching is 30 minutes per period, seven periods per week.

The prominent finding is that the time allocated for Natural Sciences (NS) in the Intermediate Phase (IP) is 3 hours 30 minutes, as is required by policy and as is the response of seven participants out of 13.

Participant P1 expressed her view with regard to 6 periods versus time taken because 3 hours 30 minutes makes up seven periods. Two participants, P5 and P6 shared a different view of the relationship between periods and time taken for one period because seven hours stated by them is the contact time for educators on daily basis, an incorrect response as that would mean that NS would be taught for the whole day.

The response by P12 which says 30 minutes per period, seven per week concurs with the response of seven participants who said the allocated time for NS teaching is three hours 30 minutes. Therefore eight participants shared the same view on time allocated for NS teaching in the Intermediate Phase.

2. *How best can the allocated time be spread amongst the three learning outcomes?*

Table 4.4: Time spread amongst the three learning outcomes (LO 1, LO 2, and LO 3)

	Time spread	Participants	Frequency
1	LO 1 needs more time (TS 1)	P1, P12, P13	3
2	LO 1 is practical work (TS 2)	PP1	0
3	Each LO 1 will take 1 hour 10 minutes (TS 3)	P2	1
4	Depend on the level of understanding (TS 4)	PP5	0
5	1hour 30 minutes for each strand (TS 5)	P3, P5, P9	3
6	Inseparable LO with separated topics (TS 6)	P8	1
7	[[The outcomes will never be achieved (TS 5)]]]	P10]]]>>>>	1
8	2 hours for LO 2, 2hours for LO3, 3hours 30 minutes for LO 1 (TS 7).	P4]]]>>>>	1
9	[[LO 1 depends on educator's preparation and resources (TS 8)]]	P6	1
10	We give it 2, 2, 2 each (TS 9)	P11	1
11	Scientific investigations need more time (TS 10)	P7	1
12	Integrate LOs, focus on LO 1(TS11)	PP9	0
13	Depend on the depth of each learning area (TS 12)	PP12	0

Table 4.4 shows that four participants (P1, P6, P7, P12, P13) out of 13 agreed that LO 1: Scientific Investigations, needs more time whereas three participants (P3, P5, P9) think that the time should be divide equally by three and to give 1 hour 10 minutes to each LO. But Participant P7 stated that the time amongst the learning outcomes should be divided equally. Participant P8 said that the learning outcomes are inseparable, only the topics may differ. Participant P10 stated that the outcome will never be achieved whereas Participant P11 responded by saying two hours for LO 2, two hours for LO 3, and three hours 30 minutes for LO1 might be achieved.

The statement by Participant P4 is ambiguous and expressed a different view on time spread amongst the three outcomes (LO 1, LO 2 and LO 3). Participant P7 expressed her view differently as well because dividing by 2, 2, and 2 means nothing, whereas P11 stated that two hours is allocated for LO 2 and 3 hours is allocated for LO 3 whereas NS Intermediate Phase only has seven (7) periods per week.

Participant P11 confused the question asked with the previous question on time allocated for three LOs in Natural Sciences in the Intermediate Phase.

The finding is that all the responses of the thirteen (13) participants are consistent with the NCS policy and above all it is true that scientific investigations need more time than LO 2 and LO 3.

3. *How many strands are there in the RNCS policy Natural Sciences in the Intermediate Phase?*

Table 4.5: Strands which should be taught on the NCS policy for Natural Sciences in the Intermediate Phase

	Time spread	Participants	Frequency
1	Four strands: • Live and living, • Energy and Change, • Planet earth and Beyond, • Matter and Material (S 1)	P1, P2, P5, P8, P9, P10, P11, P13	8
2	They are five of them (S 2)	P4	1
3	They are three (S3)	P12	1
4	There are four strands (S 4)	P3, P6, P7	3

Table 4.5 depicts that the eight participants (P1, P2, P5, P8, P9, P10, P11, and P13) stated that four strands should be taught in Natural Sciences in the Intermediate Phase and went further to name them as ñ Life and Livingò, ñEnergy and Change,ò ñPlant Earth and Beyondò, ñMatter and Materialò. Only three participants (P3, P6 and P7) reported that there are four strands in the NCS policy Natural Sciences in the Intermediate Phase, but did not mention the strands. Lastly, Participant P4 stated that there are five strands whereas Participant P12 said that the strands are three which are to be taught in the Natural Sciences policy in the Intermediate Phase.

The finding is that there are four strands which are to be taught in Natural Sciences in the Intermediate Phase. Eight participants (P1, P2, P5, P8, P9, P10, P11, and P13) shared the same view on strands to be taught in the Intermediate Phase (IP).

In addition, as stated above, three (3) participants (P3, P6, and P7) were doubtful because they were supposed to name the strands. The response by two participants, P4 and P12 expressed their views as well on the strands to be taught in Natural Sciences in the Intermediate Phase.

4. *Do you think the time allocated for each strand is enough based on the work?*

Table 4.6: Allocated time for each strand

	Allocated time for each strand	Participants	Frequency
1	Life and living need more time, content is broad (TSE1)	P1, P13	2
2	Time not enough, language barrier (TSE 2)	P2, PP2, P6, P7, P8, P10, P11	**6**
	[[[Lack of laboratories and other resources (TSE 3)	PP3]]]>>>>	0
3	Research take long time (TSE 4)	P3, P 4, P12	3
4	The level of understanding is vital (TSE 5)	P5	1
5	All four strands are to be taught in each term (TSE 6)	P9	1

As illustrated in Table 4.6, the three participants (P3, P10, and P12) thought that the time allocated for each strand was not enough in general whereas the two participants, Participant P1 and P13, answered that Life and Living strand need more time. Only Participant P2 stated that learners have language barrier, lack of laboratories and other resources is a problem. Participant P4 said that the time is not good enough. In contrast, four participants (P6, P7, P8, and P11) stated that the allocated time is enough. Participant P5 stated that the time allocated is enough based on the learners level of understanding. Participant P9 gave an interesting view saying that four strands are to be taught in one term and as a result, learners get confused and educators confuse the learners as well. Participant P10 stated that teaching is a life time; therefore time for teaching will never be enough. In total, 10 participants (P1, P3, P4, P5, P6, P7, P8, P10, P11 and P12) stated that time allocated for each strand is really not sufficient.

The responses showed the same view of the time allocation per strand when teaching Natural Sciences in the Intermediate Phase. Finally, the finding is that many participants agreed that the time allocated for each is not sufficient.

5. *Which strategies are followed when conducting scientific inquiry?*

Table 4.7: The strategies followed when conducting scientific inquiry

	Time spread	Participants	Frequency
1	Observing, investigating, experimenting, comparing, listening, and sorting (SG 1)	P2, P10, P12,P13	4
2	No specific strategy, only understanding research (SG 2).	P4, P8	2
3	Recording, measuring and planning (SG 3)	P6	1
4	Visit to company experts, library or laboratory for experiments (SG 4)	P3	0
5	Promotion of scientific literacy (SG 5)	PP4	0
6	Observation is the best (SG 6)	P7	1
7	Independent learning by learners (SG 7)	P9	1
8	Investigation (SG 8)	P11	1
9	Observation, measuring and exploration (SG 9)	PP12	0

Table 4.7 depicts that the five participants (P2, P6, P10, P12 and P13) out of 13 had the same opinion that observing, investigating, experimenting, comparing, listening, and sorting are strategies to be followed when conducting scientific inquiry whereas two participants, P4 and P8, said that knowledge and understanding of research is vital. Participant, PP 4 further stated that promotion of scientific literacy is also an assessment strategy when conducting scientific inquiry. Participant P6 stated that recording, measuring and planning are assessment strategies when conducting scientific inquiry.

Participant P3 said that assessment strategies used when conducting scientific inquiry is like a visit to a company or experts, library or laboratory for experiments. Two participants, P1 and P5 uttered incomplete statements showing less knowledge on the assessment strategies. Participant P9 stated that space for learners to perform experiments for themselves is needed. Participant P11 answered by saying that investigation is the only assessment strategy. Participant P12 answered by saying that observation, measuring and exploration by learners are the correct assessment strategies. Lastly, two participants, P1 and P5 uttered incomplete statements showing a different on the question.

The finding is that many participants (seven in number) know the strategies used when conducting scientific inquiry against six who does not know strategies used when conducting scientific inquiry.

6. What is the level of learner participation during classroom teaching?

Table 4.8: Level of learner participation during classroom teaching

	The level of learner participation	Participants	Frequency
1	Average participation (LLP 1)	P1	1
2	Language barrier (LLP 2)	P2	1
3	Highly gifted, moderate and below average (LLP 3)	PP2	0
4	Very high participation(LLP 4)	P3, P8, P12	3
5	Level is very low (LLP 5)	P4	0
6	Usage of mother tongue (LLP 6)	PP1]]]>>>	1
7	Learners are passive listeners (LLP 7)	PP4	2
8	They participate (LLP 8)	P5, P11	1
9	Actively involved (LLP 9)	P6	1
10	Positively involved (LLP 10)	P7	2
11	It was satisfactorily (LLP 11)	P8, P9, PP11	1
12	It was good (LLP 12)	P13	

Table 4.8 shows that three participants (P3, P8 and P12) responded to this question saying that learner participation in the lessons was high. Participant P1 stated that learnersô participation was average due to language barrier. Participant P2 grouped learners into three categories namely highly gifted, average and below average. P4 stated that the level of participation is very low due to language barrier and as a result, learners become passive listeners. Two participants, (P5 and P11) concurred that learner participation is generally well. Four participants (P6, P7, P9 and P11) responded that learners were actively, satisfactorily and well involved while some were and passively involved.

The finding is that eight participants (P3, P5, P6, P7, P8, P9, P11 and P12) stated that learner participation was good.

7. Which resources do educators use when conducting Scientific Investigation?

Table 4.9: The resources educators use when conducting scientific investigation

	Resources	Participants	Frequency
1	Lack of physical resources (R1)	P1, P6, P8,P13	4
2	Plants and animals (R1)	PP1	0
3	Lack of textbooks, pamphlets and chalkboard (R2)	PP8, P11,P13	2
4	Lack of laboratories… (R3)	P2	1
5	Resort to natural resources. (R4)	PP2	0
6	Resources, depends on the topic (R5)	P3, P5,P7, PPP8, P9, P10, PP11, PP12	5
7	Knowledge as the best resource (R6)	P4	1

Table 4.9 shows that four participants (P1, P6, P8 and P12) listed physical resources such as animals and plants, a scientific centre and material as important resources. Two participants (P11 and P13) stated other resources like textbooks, pamphlets and material as important resources. Participant P2 stated the importance of laboratories but highlighted that as laboratories were non-existent, they had to resort to natural resources instead. Five participants (P3, P5, P7, P9 and P10) responded by saying the resources depend on the topic. It was surprising to find out that Participant P4 regarded knowledge as a resource.

The finding is that a total of 10 participants (P1, P2, P5, P6, P7, P9, P10, P11, P12, and P13) know the resources to be used when conducting scientific investigations.

4.3.2 The Integration of Assessment Standards

The questions below are based on **integration of assessment standards** (NCS policy) when conducting scientific investigations and subsequently the sub-question (see Chapter 1) was used as a frame of reference for the interview questions asked below: *How do educators integrate and teach scientific investigations in the Intermediate Phase?*

The purpose of the interview questions was to understand what the importance of focus questions (those questions posed by educators and learners to steer the direction of an investigation) are to teachers.

8. *In your opinion, what is a focus question when conducting Scientific/focus knowledge/Investigation?*

Table 4.10: Understanding the importance of questions to focus the investigations

	Focus questions	Participants	Frequency
1	In food chain all components are vital(FQ1)]]]	P1>>>>	1
2	The questions depend on the critical thinking (FQ 2).	P2, P3	2
3	LO 1 is planned, but (LO 2)is achieved (FQ 3)]]]]	P4	1
4	Introduction of science depend on learners' level (FQ 4).	P5	1
5	Celsius thermometer is used to measure temperature(FQ 5)	P6	1
6	Observation is a good strategy (FQ 6)	P7	1
7	Learners be involved in research question (FQ 7)	P8, P11	2
8	Main objective of the lesson (FQ 8)	P9	1
9	Change a problem into a question (FQ 9)	P10	1
10	Plants respond to external factors (FQ 10)	P12	1
11	Resources needed, scientific thinking be encouraged (FQ 11)	P13	1

Table 4.10 shows that two participants (P2 and P3) showed an understanding of a focus question by stating that the question should include the ñwhy, ñhow longò and ñwhyò but could not formulate one in their lessons. Participant P1 statement showed a different view of a focus question at all. Participant P4 stated that when you conduct the LO 1: Scientific Investigations, one will be achieving the LO 2: Constructing Science Knowledge.

The statement made by Participant P4 further showed that the participant cannot separate the LO 1 and LO 2. Two participants (P8 and P11) answered that the focus question is basically asked and embraces the whole research. Participant P5 stated that a focus question is based on introduction of science knowledge according to the level of these learners. Participant P6 used iron bars which are left on the sun and Celsius thermometer is used within an hour to measure temperature. Participant P7 referred to observation as a strategy to get learners to understand and describe what they observe. Participant P9 said that focus question should be regarded as the main or objective of the lesson during investigation.

Participant P10 stated that a focus question is the ñhowò andò whyò, identify a problem and change it into a question. Participant P12 wanted learners to identify or see for themselves the plant behaviour or the plant movement caused certain external factors. Participant P13 stated that the problem is presented to the learners for them to do individual research with relevant resources.

The finding is that only six participants (P2, P3, P8, P10, P11 and P 13) shared the same view a focus question although only participant P6 stated a question on ñ how heat is transferred?. The remaining seven participants (P1, P4, P5, P6, P7, P9 and P12) expressed different views the focus question. The conclusion is that participants never shared the same view on the focus question.

9. *How do you ensure that the question is not answered by "yes" or "no", but is researchable?*

Table 4.11: Characteristics and purpose of the researchable question

	Researchable question	Participants	Frequency
1	They will have to know, or how…(incomplete) (RQ 1)	P1	1
2	Stimulate critical thinking of learners (RQ 2)	P2	1
3	Allows learners to do independent research (RQ 3)	P3, P5, P6, P9	4
4	Acquainting learners with the question itself (RQ 4)	P4	1
5	Don't ask questions that need "yes or no" (RQ 5)	P7	1
6	Should be clear (RQ 6)	P8	1
7	Must be exploring, it must be "why and how"(RQ 7)	P10, P12	2
8	Should be open ended (RQ 8)	P11, P13	2

Table 4.11 depicts some understanding of the researchable question by four participants (P3, P5, P6, and P9) because all of them agreed on the characteristics and purpose of a researchable question which is for learners to engage in an independent research, step by step and following the relevant method. Three participants (P8, P10, P12) stated that the researchable question should be clear, challenging and be explanatory like ñhowò. Two participants (P11 and P13) said that researchable questions should be open-ended.

Participant P1ôs statement was incomplete due to little understanding of the researchable question. Participant P2 stated that the researchable question stimulates critical thinking of learners. Participant P4 mentioned that the purpose of a researchable question is to acquaint learners with research only. This is not sufficient if learners are required to conduct a research on their own. Participant P5 said that one should not ask questions that need a ñyes or noò as such response are not benefiting the learners. This responds shows that the Participant P5 has a different view on the purpose of the researchable question.

The finding is that nine participants shared the same view on a researchable question although they could not formulate one in their observed lessons.

10. How do you plan an investigation and how do you teach the planning?

Table 4.12: Planning an investigation

	Planning an investigation	Participants	Frequency
1	Learners be included during planning (PI 1)	P1, P5, P9, P10	4
2	Include interesting activities (PI 2)	PP1	0
3	Allow for independent investigation (PI 3)	PPP1	0
4	Identify the (LO) (PI 4)	P2, P6, P7, P8, P12, P13	6
5	Bear resources in mind when planning (PI 5)	PP2	0
6	[[[Statistics be forwarded beforehand (PI 6)]]]	PPP2]]]>>>	0
7	Search for information be planning (PI 7)	P3, P11	2
8	Link LO 1, with assessment standard (PI 8)	PP3	0
9	Plan according to RNCS (PI 9)	P4	1
10	Assessment standards be used during planning (PI 10)	PP4	0

Table 4.12 shows that six participants (P2, P6, P7, P8, P12 and P13) regarded resources as a major requirement for successful planning for an investigation, but they were not teaching learners how to plan an investigation during their presentation when observed by the researcher.

Four participants (P1, P5, P9 and P10) stated that learnerôs interest should be considered when planning for the investigation and planning should allow for independent investigation. Participant P3 stated that good planning requires the educator as planner to visit library, laboratory, home and industries to get information beforehand. Two (2) participants (P3 and P11) are policy driven because they stated that learning outcomes (LOs), assessment standards and topic from NCS policy should be linked together.

The prominent finding is that six participants (P2, P6, P7, P8, P12 and P13) who stated the importance of resources in their planning did not have nor use resources during their presentation observed. Although the importance of resources during planning for an investigation cannot be overemphasised, the six participants have not said how those resources could be used by learners. They answered the first part of the question and due to their views on teaching planning; they could not answer the second part of the question on how to teach planning to the learners before embarking on an investigation. Moreover, not all investigations need physical resources hence schools do not have the resources. Four participants (P1, P5, P9 and P10) showed a different view because they stated that when planning for an investigation they should consider including learnersô interesting activities which should be done by learners independently.

11. Where and when to conduct a scientific investigation?

Table 4.13: Suitable place and time to conduct scientific investigations

	Place and time to conduct scientific investigations	Participants	Frequency
1	Conducted within the classroom (PT1)	P1	1
2	Outside the school yard (PT2)	P2	1
3	At home, during the night, during the day (PT 3)	P3	1
4	In order to prove some of the answers (PT 4)	PP3]]]>>>>	0
5	Research from the book in the library (PT5)	PPPP3	1
6	Get information from other expects on the topic (PT8)	P3, P4	0
7	when we want to improve the other methods of scientific investigation using the project research (PT 10)	PP4	1
8	At the beginning, at the end, during	P5, P6, P8, P9, P10,	6

	Place and time to conduct scientific investigations	Participants	Frequency
	the lesson or even before and after the lesson (PT 11)	P13	
9	[[[If the strand requires a research, then it should be conducted.	P7]]]>>>	1
10	[[[It is done when checking on LOs and topics of that term (PT 13)	P12]]]>>>	1
11	[[[It is done to prove highly scientific matter taught (PT14)	P12]]]>>>	1

Table 4.13 shows that six participants (P5, P6, P8, P9, P10 and P13) responded commonly and said that scientific investigations can be conducted at the beginning, during the lesson and at the end of the lesson depending on the time available whereas the response by six participants (P1, P3, P4, P7, P11, and P12) showed little or no understanding. Lastly, Participant P2 showed no understanding.

The prominent finding is that seven participant expressed their views. Participant P2 stated that the suitable place and time to conduct scientific investigations is outside the school yard. Lastly, Participant P2 shared her different view the question asked. In conclusion, the participants do not know where and when to conduct scientific investigations.

12. *How long can it take learners in the Intermediate Phase to conduct a scientific investigation? (Week/month/year)*

Table 4.14: Time to be taken to complete scientific investigations

	Time to complete scientific investigation	Participants	Frequency
1	The findings may be needed within a day or weeks (TC1)	P1, P2, P8	3
2	It can take up to three (3) months (TC2)	P3	1
3	[[[simple investigation, library, pictures and textbooks be used as resources (TC3)]]]	P6]]]>>>	1
4	Minor project take a week or a month (TC4)	P4, P5	2
5	It depending on the strand (TC 5)	P7	1
6	Scientific Investigations need a week (TC6)	P9, P10, P11,P12	4
7	Scientific Investigations involves steps(TC7)	P13	2

Table 4.14 shows that four participants (P9, P10, P11 and P12) out of 13 responded and said that scientific investigation need a week to complete. Three participants (P1, P2 and P8) responded that although it depends on the content of the lesson, it may be completed within a day, one week, two or three weeks. Two participants (P4, P5) brought a very relevant aspect ñprojectsò and stated that projects investigations may take a week or a month. Only Participant P7 stated that the time needed to complete the scientific investigations depended on the length of the strand which shows that the participant confuses scientific investigations with the focus knowledge or topic to be taught in a particular strand. P3 stated that scientific investigations can take three months depending on the topic.

The prominent finding is that 10 participants (P1, P2, P4, P5, P8, P9, P10, P11, P12 and P13) shared the same views of the time to be taken to complete a scientific investigation in the Intermediate Phase as ñweeks or monthsò not a year.

13. Which sources of data are readily available to educators and learners?

Table 4.15: Sources of data available to educators and learners

	Sources of data	Participants	Frequency
1	The textbook is readily available (SD 1)	P1, P5, P7, P10, P11, P13	6
2	The natural resources are readily available (SD 2)	PP1	0
3	Rubric is one of the sources which are readily available (SD 3)	P2, P3	2
4	The sources of data depend on the lesson (SD 4)	P9	1
5	Sources of data refers to questions prepared by educators beforehand(SD 5)	P12	1
6	Internet, achieves in library (SD 6)	P4	1
7	All equipment including library (SD 7)	P6	1
8	Policies including NCS, educator guides, textbooks and small laboratory (SD 8)	P8	1

Table 4.15 shows that six participants (P1, P5, P7, P10, P11 and P13) rely on textbooks for scientific investigations, and as a result, they engage learners on confirmatory experiments rather than authentic scientific investigations.

Participant P1 further stated natural resource as a source of data, but could not give an example like water or soil. Participants (P2 and P3) gave the rubric as a source of data whereas it is the assessment tool for projects. This showed little no understanding of the sources of data when conducting scientific investigations. P4 stated internet, achieves in library as sources of data but unfortunately the majority of schools do not have internet connectivity, let alone libraries. Participant P6 stated that data can be collected anywhere including libraries, but this could be a problem as many schools do not have libraries.

Participant P9 is the only educator who answered by saying that the sources of data depend on the lesson. Only Participant P12 stated that sources of data depend on the lesson and assist educators to prepare questions before the lesson commences. Lastly, three participants (P8, P9, and P12) statements are integrating because during lesson design, assessment planning, educators use guides, NCS policies to collect data depending on the topic to be presented by educators with questions instructing learners on strategies and methods to be used when collecting data.

The prominent finding is that the latter three participants (P8, P9, and P12) expressed their views on the sources of data whereas majority of participants expressed their different views as well on data before, during or after scientific investigations are conducted.

14. Where and how to collect data?

Table 4.16: Place and instruments used for collecting data

	Place and instrument for collecting data	**Participants**	**Frequency**
1	Within and outside the classroom (PLI 1)	P1, P2, P5, P8, P13	5
2	Outside, at home or in the laboratory (PLI 2)	P3	1
3	Linking information sequentially (PLI 3)	P4	1
4	Anywhere, textbook, pictures, library (PLI 4)	P6, P7	2
5	Depends on the lesson and topic (PLI 5)	P9, P11	2
6	Anywhere using the instrument (PLI 6)	P10	1
7	Pictures, questionnaires, internet (PLI 7)	P12	1

Table 4.16 reflects that five participants (P1, P2, P5, P8 and P13) stated that data should be collected in the classroom, outside the classroom, but could not mention the instrument to be

used for data collection, except Participant P12. Two participants (P6 and P7) stated that data should be collected anywhere from textbooks, pictures and the library. Participant P9 and P11 stated that data can be collected depending on the lesson and topic. Participant P3 stated that data can be collected from outside, at home or in laboratory. Participant P4 stated that data would be found after compiling information, sequentially to have meaning to each of them. Participant P10 argued that data can be collected anywhere using the instrument. Participant P12 said that data could be collected in the form of pictures, questionnaires, internet and technological processes.

The prominent finding is that only two participants (P9 and P11) shared the same view when stating that data collection depends on the lesson and type of the topic and Participant P12 who said that data can be collected in the form of pictures, questionnaires, internet and technological processes. Participant P3 was partially correct when stating that the library is a place where data can be collected.

15. How do you evaluate data?

Table 4.17: Methods of data evaluation

	Methods of data evaluation	Participants	Frequency
1	Compare the findings with research question (DE 1)	P1	1
2	Findings represented on tables, graphs or maps (DE 2)	P2	1
3	Through a graph, doing statistics calculations (DE 3)	P3	1
4	Project or verbal questioning or class works (DE 4)	P4	1
5	[[[Learners given practical demonstration (DE 5	P5]]]>>>	1
6	Learners given rainfall graph (DE 6)	P6	1
7	Data collection task given (DE 7)	P7	1
8	Observe and record (DE 8)	P8	1
9	Depend on the lesson (DE 9)	P9	1
10	Learners data must assist them (DE 10)	P10	1
11	Giving learners some tasks (DE 11)	P11	1
12	Check consistency and pattern (DE 12)	P12	1
13	Measure the growing plants (DE 13)	P13	1

Table 4.17 shows different statements uttered by the 13 participants. Participant P1 said that data evaluation referred to comparing the findings with what you intend to achieve during

investigation. This statement is relevant during confirmatory investigation only. Three Participants (P2, P3, and P6) said that through observation, supporting the findings through tables, graphs, projects, and maps are methods of data evaluation, but none of them could plot the graph, use the table or demonstrate showing understanding of data evaluation.

Participant P4 stated that by giving learners the project or by verbal questioning or class work are the methods of data evaluation. It is clear that the latter participant confuses data evaluation methods with assessment methods. Participant P5 stated that by giving learners a project on how to feel air (using their hands outside) and on how to draw their four cardinal points of a direction are demonstration methods. It shows that the participant confuses demonstration with the data evaluation methods. Participant P6 said that by giving learners the graph for rainfall, if inconsistent data results, the process shall be repeated. This is an indication that the participant is thinking of consolidation.

The prominent finding is that four participants (P1, P2, P3, and P6) expressed a different view on how to evaluate data. Six participants (P4, P5, P7, P8, P9, and P10) shared the same views on data evaluation. Only Participant P12 showed confidence on data evaluation.

16. How do you teach learners to analyse data, what do you do with the inconsistent data?

Table 4.18: Teaching learners to evaluate data and dealing with the inconsistent data

	Teaching data evaluation and dealing with inconsistent data	Participants	Frequency
1	Learners learn correct things, throw inconsistent data (ID 1)	P1	1
2	Learners learn how to analyse data (ID 2)	P2	1
3	Encourage, support learners to think critically (ID 3)	P3	1
4	Arrange findings in sequence (ID 4)	P4	1
5	Group leaders report on findings (ID 5)	P5>>>	1
6	Throw it away (ID 6)	P6	1
7	Give feedback and allow for observation (ID 7)	P7	1
8	They follow guiding question, repeat the research (ID 8)	P8	1
9	Teach learners to get average (ID 9)	P9	1
10	No knowledge of that (ID 10)	P10	1
11	Learners should change it for parting	P11	1

	Teaching data evaluation and dealing with inconsistent data	Participants	Frequency
	(ID 11)		
12	Get pattern with consistent data, throw away inconsistent data (ID 12)	P12	1
13	More or less answers show inconsistency (ID 13)	P13	1

Table 4.18 shows different views stated by all the 13 participants. Participant P1 spoke about correct things to be learnt from the experiments or research. This is an ambiguous response because the ñcorrect thingsò can mean many things. The statement uttered by Participant P1 that inconsistent data should be óthrown awayô or be put aside is not related to the teaching of data evaluation said during interview. Participant P2 stated that learners should be taught how to analyse data by checking the weak and strong point on the data. The checking of the weak and strong point is not answering either of the two questions.

Participant P3 spoke about compiling, knowing and understanding it, then know how to proceed to put it according to the way it must follow the sequential but the statement is not relevant to Participant teaching data evaluation and dealing with the inconsistent data. Participant P4 has already jumped to communicating the findings not teaching data evaluation and dealing with inconsistent data. Participant P6 just answered part two of the question stating that inconsistent data will be thrown away. P7 stated that giving feedback and observation are key issues but the respond is irrelevant to the two questions asked.

Participant P11 said that learners should change it for parting whereas Participant P10 responded by saying that she does not know the answer to the question. Participant P13 stated that if learners give more or less the same responses then that is consistency whereas if their responses differ, that is inconsistency.

What Participant P13 said showed that the participant does not know the processes to be followed when conducting scientific investigations. Participant P13 confuses teaching data evaluation with assessment whereby he thinks that giving different answer refers to inconsistent data.

The prominent finding is that only two participants (P8 and P12) expressed their views on data evaluation and dealing with the inconsistent data. Participant P8 stated that learners need a guiding question to analyse data when they record their data, they have to answer some of the questions, repeat experiment to have a little bit of consistency whereas Participant P12 said that when data is collected you check for the pattern, which will indicate consistency whereby inconsistency is thrown away.

17. How do you communicate the findings?

Table 4.19: Ways in which findings are communicated

	Communicating the findings	Participants	Frequency
1	Findings are written in journal (CF1)	P1	1
2	Display on notice board (CF2)	PP1	0
3	Parents do assessment (CF 3)	PPP3	0
4	Responding to question (CF4)	P2	1
5	Encourage them to observe (CF5)	P3	1
6	Each group leader present findings (CF6)	P4, P5	2
7	Inform colleges and friends (CF 7)	P6	1
8	With the HOD concerned (CF 8)	P7	1
9	With learners (CF9)	P8	1
10	In the form of a summary or a graph (CF 10)	P9	1
11	Report back by oral presentation (CF 11)	P10	1
12	Check what learners bring to grass (CF 12)	P11	1
13	Through the reports and the presentation (CF 13)	P12, P13	2

Table 4.19 shows that eight participants (P2, P3, P4, P5, P6, P7, P8, and P11) do not understand the ways in which findings can be communicated. Participant P2 stated that by talking about them, responding to the question. The statement itself is incomplete and not responding clearly to the question.

Participant P3 stated that it was important to encourage the learners to observe the investigation and give the real answers. The statement is not saying anything with regard to the ways in which findings can be communicated. Two Participants (P4 and P5) said that each group leader from various groups will present the findings but they did not state the ways in which the findings should be communicated. Three participants (P6, P7, and P8) confused the question on the ways in which the findings can be communicated with the next question which was saying ñwith whom do you communicate the findingsò because their responses were that the findings should be communicated with colleagues, friends, HOD concerned and with learners.

18. With whom do you communicate the findings?

Table 4.20: Ways in which findings are communicated with the relevant stakeholders

	Communicating the findings	Participants	Frequency
1	Findings are communicated with teachers, learners and parents (WCF 1)	P1	1
2	Findings are communicated with learners (WCF 2)	P2, P3, P5, P8	1
3	With the co-workers and Senior Natural Sciences teacher concerned (WCF 3)	P4, P12	4
4	The findings are communicated with the colleagues and friends (WCF 4)	P6	1
5	Findings are communicated with learners and people around (WCF 4)	P10	1
6	With the HOD concerned (WCF 5)	P7, P11, P13	1
7	It would depend on the lesson and relevant to the school community large (WCF 10)	P9	2

Table 4.20 shows that four participants (P2, P3, P5, and P8) responded by saying that the findings can be communicated with teachers, learners and parents. Three participants (P7, P11, and P13) said that they communicate the findings with the Head of Department (HOD) concerned whereas two participants (P4, P12) stated that they communicate the findings with the co-workers and Senior Natural Sciences teacher concerned.

Only five participants (P1, P9, P10, P12, and P13) showed that they have a better understanding of the ways/methods of communicating the findings of scientific investigations. Their responses were that the findings can be written in the book, in the form of a summary/graph and through reports or presentation.

The prominent finding is that out of 13 only five participants (P1, P9, P10, P12, and P13) showed that they have an understanding of the ways/methods of communicating the findings of scientific investigations. P1 stated that findings can be communicated with teachers, learners and parents. Lastly, the three participants (P6, P9, and P10) also communicated their findings with friends, people around them and community at large.

The prominent finding is that all the 13 participants shared the same view on communicating the findings with the relevant stakeholders.

4.3.3 Assessment for Learner Progression

The questions below are based on **assessment for learner's progression** when conducting scientific investigations and subsequently the sub-question presented in Chapter 1 was used as a frame of reference for the interview questions asked below: *How do educators assess the achievement of learners in terms of scientific investigations in the Intermediate Phase?*

The purpose of the interview question was to determine whether the documents kept by the educators in their Natural Sciences files were relevant or not, and to understand how they integrate the assessment standard during lesson presentation, their assessment strategies/techniques, assessment tools used for learner progression when conducting scientific investigations.

19. Which documents are kept by the educator in the Natural Sciences file? Name them. (Show me).

Table 4.21: Availability and knowledge of the documents kept by Natural Sciences educator in their files

	Availability and knowledge of Natural Sciences documents in the files	Participants	Frequency
1	NCS documents, lesson plans, newspaper cuttings (AK 1)	P1	1
2	NCS policy, overview teacher assessment guide (AK 2)	P2, P6, P9	3
3	Subject indexes, timetable, teachers guide, (AK 3)	P3	1
4	Table of content, annual work schedule (AK 4)	P4, P13	2
5	Record sheet, personal timetable (AK 5)	P5, P7, P8, P10, P12	5
6	Tests, assessment file, textbooks and record sheet (AK 6)	P11	1

Table 4.21 shows that four participants (P2, P6, P9, and P11) deliberated on the documents including assessment file but no assessment tool like a rubric was shown. Seven participants (P1, P5, P7, P8, P10, P12, and P13) spoke about NCS documents, work schedule provided by the government, lesson plans, newspaper cuttings and personal timetable. Two participants (P3 and P4) stated that subject indexes, timetable, teacherǿs guide, work schedule, policy documents are documents kept by the educators in Natural Sciences educatorǿs file.

Generally, all the 13 participants showed knowledge of the documents needed although they did not have them all in their possession.

The prominent finding is that all the participants expressed the same view on the documents needed for effective and efficient teaching and learning of Natural Sciences in the Intermediate Phase.

20. How many lessons designed and assessments on Scientific Investigations are there on each of the strands per term/quarter? [At least two by now]

Table 4.22: Evidence of the lessons designed and assessments on scientific investigations from any two strands

	Evidence of the lessons designed and assessments	Participants	Frequency
1	A lesson on how plants make food, a research and a project were done (LDA 1)	P1	1
2	Assessment depend on the level of understanding of the learners (LDA 2)	P2	1
3	Per term or per quarter (LDA 3)	P3	1
4	Depend on the subject matter of the day (LDA 4)	P4	1
5	In scientific investigations only, they are about five (LDA 5)	P5	1
6	It depends on how the term is (LDA 6)	P6	1
7	[[[Lesson 2, 2, each (LDA 7)]]]	P7]]]>>>	1
8	By now, two lessons and one assessment (LDA 8)	P8	1
9	Plan every week, per month, on average four (LDA 9)	P9	1
10	On one strand, four lessons on the 1^{st} strand (LDA 10)	P10	1
11	Two (LDA 11)	P11	1
12	Two lesson plans for scientific investigations (LDA 12)	P12	1
13	Every quarter can have an investigation based on the topic (LDA 13)	P13	1

Table 4.22 shows that eight participants (P3, P4, P5, P6, P7, P9, P10, and P11) showed little or no understanding of how to design the scientific investigation lesson plan and its assessment thereof.

Participant (P3) stated that ñper term ñor ñper quarterò which shows that the participant was confused or totally lost. Five participants (P1, P2, P8, P12, and P13) showed a better understanding of the question on lesson designed and planned assessment. Out of the five participants (P1, P2, P8, P12, P13), two participants (P1, P8) spoke about projects or tests as a form of assessment but there was no rubric mentioned as an assessment tool for the project.

The prominent finding is that majority of participants, eight participants, did not have the lesson planned to demonstrate how to conduct scientific investigations, planned assessment and the rubric to mark the project or assessment.

21. When designing the lesson plan, does the educator explicitly show the integration of the assessment standards when conducting scientific investigation?

Table 4.23: Explicitness of the integration of assessment standard in the lesson designed (planned)

	Explicit of the integration of assessment standard	Participants	Frequency
1	A lesson using demonstration (EI 1)	P1	1
2	Highlight and abbreviations (EI 2)	P2	1
3	Yes (EI 3)	P3, P7, P10, P11, P12, P4	5
4	Integrate the Learning areas (EI 4)	P5	1
5	Yes, usually trying to show them.(EI 5)	P6	1
6	Yes, use internal and external integration (EI 6)	P8	1
7	Yes, because integration is done with assessment standards (EI 7)	P9]]]>>>	1
8	[[[Sometimes integration is impossible with other assessment form (EI8)]]]	P13	1
9	Conducting the scientific investigation (EI9)		1

Table 4.23 shows that five participants (P3, P7, P10, P11, and P12) just answered ñyesò only without elaboration, which showed how much they knew about the integration of assessment standards when conducting scientific investigations. Participant P1 does not answer the question asked on whether on her lesson planned the integration of assessment standards are explicit or not. Participant P2 also stated that integration of the assessment standards is not compulsory; hence we know that the assessment standards for scientific investigation are inseparable for proper completion of the research itself.

Three participants (P6, P8 and P9) responded by saying ñyesò, but their elaboration showed that they do not know that assessment standards for LO 1 (Scientific Investigation) are inseparable as a processes for a complete research. Participant P6 referred to internal and external integration similar to integration within and across other learning areas. Participant P9 agreed saying ñyesò but stated that integration is impossible with other ñassessment formò. Only participant (P13) showed knowledge of how to integrate the assessment standards when conducting scientific investigations. The prominent finding is that all the thirteen (13) participants used the word integration based on their own context.

22. Are there any records/projects done by learners previously to prove the educator understands of scientific investigations (LO1)?

Table 4.24: Availability of the records/projects done by learners

	Availability of the records/projects	Participants	Frequency
1	Yes, they are behind (AR 1)	P1	1
2	Yes, there are examples of them (AR 2)	P2	1
3	Yes (AR 3)	P3, P6, P7, P11	4
4	Yes, there are a lot of them (AR 4)	P4	1
5	Yes, learners are given many projects (AR 5)	P5	1
6	Yes, they were given mind map AR 6)	P8	1
7	There are projects that they have done (AR7)	P9	1
8	There are learners record of work (AR 8)	P10	1
9	Very few of them (AR 9)	P12	1
10	Not yet, they are still trying (AR 10)	P13	1

Table 4.24 indicates that four participants (P3, P6, P7, P8, P11) responded by just saying ñyesò without further explanation. Three participants (P1, P10, P12) responded by a ñyesò but their motivation was not convincing that they had projects or evidence to prove their points. Only three participants (P2, P4, and P9) showed a better understanding of the question by showing the records of the projects and concrete projects were shown to the researcher.

The prominent finding is that 10 participants out of 13 participants expressed their views on how to assist learners make projects and there were not records to show that the projects were once available or done by learners at some stage.

23. Which records kept by the educator are used to evaluate learner performance/progression?

Table 4.25: Knowledge of records kept, tools used to evaluate learners for progression/performance

	Records kept, tools used to evaluate learners progression/performance	Participants	Frequency
1	Rubric used as the tool for project (RP 1)	P1, P11, P12, P13	4
2	The assessment sheet and (RP 2)	P2, P3, P5, P6,	5
3	The records are the same (RP 4)	P10	1
4	Test, memorandum, mind map and record	P4	1
5	Sheet for marks (RP 5)	P8	1
6	Files and recording marks are kept (RP 6)	P9	1
7	Records sheet, which shows levels (RP 7)	P7	1

Table 4.25 shows that four participants (P1, P11, P12, and P13) showed an understanding of the rubric as the assessment tool and marks are recorded in the mark sheet. Seven participants (P2, P3, P5, P6, P7, P9, and P10) spoke about mark sheet, the assessment sheet for progression but never said anything about rubric as an assessment tool for project. The mark sheet, record sheet and assessment sheet could also be used for LO 2: Constructing Science Knowledge and LO 3: Science, Society and Environment. Their responses showed little or no understanding of how to conduct scientific investigations. P8 made mention of test, memorandum, mind map which are more associated with LO 2: Constructing Science Knowledge and LO 3: Science, Society and Environment. P4 spoke about the records, the very same one which we have as the assessment standards in the RNCS gazette are the ones to be used when evaluating the learner which showed that the participant had no knowledge or no understanding of the question.

The prominent finding is that only four participants (P1, P11, P12, and P13) expressed their views on the records kept and assessment tool (rubric) used to evaluate learners for progression. Nine participants (P2, P3, P4, P5, P6, P7, P8, P9, and P10) expressed a different view on records kept and assessment tool (rubric) to assess scientific investigations or projects.

4.4 OBSERVATIONS AND DOCUMENT ANALYSIS

4.4.1 Introduction

Before observations and document analysis could commence, all participants held pre visit meetings whereby the researcher explained what is expected of the participants who agreed to take part in this study. It was made clear that all participants must prepare lesson plans on scientific investigation, because LO 1: Scientific Investigation is the focus of this research. It was vital so that participants should not prepare the LO 2: Constructing Science Knowledge using the school template which must be submitted to the researcher beforehand together with the Natural Sciences educator file in which all the documents are kept. There are various reasons for why the communication was done.

The most vital one was that the participants should prepare lesson plans on the LO 1 (Scientific Investigation) which is the focus of the research rather than focusing on LO 2 (Constructing Science knowledge) and LO 3 (Society and Environment). During classroom observation as the researcher, I had to follow all the activities including the integration of the assessment standards by the educators and learner`s responses against what is submitted on the temple. Lastly, sometimes some educators take lesson preparation for granted therefore I had to safeguard against those embarrassment at the end of the classroom observation.

All participants must also be prepared for the interviews either immediately after the lesson was observed or any suitable time afterwards. Observation checklists and document analysis for educators teaching Natural Sciences in the Intermediate Phase (Participants 1-13) is attached as Annexure A. Observation checklist was necessary to check whether the educators were able to indicate the integration of assessment standards or not when conducting scientific investigation on the lesson designed (planned), to display the integration of assessment standards during lesson presentation and how to assess the learner`s task and the instruments used for assessment.

The educators files were also checked especially the types of tasks given and the assessment instruments kept. The instruction was given to the participants as indicated in the paragraph 4.4.1 above.

The observation checklist was divided into three (3) parts. In part 1, each mark was allocated on the lesson plan prepared, if it was indeed a scientific investigation with assessment standards indicated. In part 2, during lesson presentation, the educators were checked to see if indeed the assessment standards were integrated when conducting scientific investigation and a mark was allocated as well.

In part 3, the educatorõs files were checked to see if there were tasks like projects, investigations, researches with the relevant instruments like rubric. As the researcher, I think they understood the instruction because on their lesson plan template they wrote well that the lesson was on scientific investigation with the relevant assessment standards but it became a problem when they were to put the theory into practice. The observation of educators in practice was important to determine their understanding of how to interpret and integrate the assessment standard when conducting scientific investigation.

Table 4.26: Summary of first observed lesson presentations

Partici-pants	Gr	Topic	Planning scientific investigations (focus question)	Conducting scientific investigations and data collection	Evaluation data and communicating the findings	Type of Assessment and tool used	Introduction
P1	4	Food chain	Educator have no knowledge of planning a scientific investigation	Learners went out to collect small animals (ants). No focus question	It was not done. Educator used question and answer method	Question and answer method was applied. Hands-out were given	Educator took six minutes revising previous work on LO 2
P2	6	Vertebrate and invertebrate animals	No knowledge of scientific planning. She did plan for the lesson, but not for LO 1	Scientific investigation not conducted. No data collection done	No data evaluation and communication of findings	Hand-outs were given to answer questions and oral responses by learners	Educator used pictures for living and non-living animals
P3	5	Three (3) phases of water	Planning for scientific investigation was done but educator herself	Scientific investigation was conducted. Confirmatory experiment done	Data evaluation and communicating findings not done	Orally and chorally done followed by round of applauses	Water was pour to the ground as demonstration that it is a liquid
P4	6	Transfer of heat (Convection)	No planning for scientific investigation was done	Scientific investigation not conducted	Data evaluation and communicating findings not done	Learners were passive listeners. No question and answer method	Demonstration by boiling water was done. Educator took much of time
P5	4	The building blocks of life	No planning for scientific	Scientific investigation not	Data evaluation and	Learners dominated the	Educator had more knowledge

Partici-pants	Gr	Topic	Planning scientific investigations (focus question)	Conducting scientific investigations and data collection	Evaluation data and communicating the findings	Type of Assessment and tool used	Introduction
			investigation was done. Too much of LO 2 was done	conducted	communicating findings not done	lesson, oral assessment was done	to offer but not on LO 1
P6	6	Primary and secondary sources of electricity	No planning for scientific investigation was done	Scientific investigation not conducted	Data evaluation and communicating findings not done	Learners participated well	Educator achieved too much of LO 2 and LO 3
P7	6	Energy and change	No knowledge of scientific planning	Scientific investigation not conducted	No data evaluation and communication of findings	Good learner participation	Educator achieved LO 2 and LO 3 not LO 1
P8	7	An experiment to confirm direction of convectional current	Well planned by educator, but learners were not taught how to plan it on their own	Well conducted, but learners were not told to collect data	No data evaluation because it was not collected.	Learner involvement was satisfactorily	It was well demonstrated by educator.
P9	6	Tropism	Planning was done by the educator	No scientific investigation conducted	No data collection	Learner participation good	Educator introduced his lesson well
P10	4	How do plants	From the	Teacher	Not done.	Oral answering.	More of LO 2 and

Partici-pants	Gr	Topic	Planning scientific investigations (focus question)	Conducting scientific investigations and data collection	Evaluation data and communicating the findings	Type of Assessment and tool used	Introduction
		use light energy?	observation it appeared as if the teacher had no knowledge of how planning had to be done	demonstrated two plants drawn on the chalk board. No scientific investigation.			LO 3 was ad-dressed as LO 1
P11	4	Moving air, temperature, weather condition	No knowledge of scientific planning	Scientific investigation not conducted	No data evaluation and communication of findings	Orally and chorally responds from learners	Educator presented more LO 2 and LO 3
P12	6	Solar system	Planning scientific investigations (focus question)	Conducting scientific investigations and data collection	Evaluation data and communicating the findings	Orally and chorally responds from learners	Educator taught about distance of planets
P13	4	Cardinal points-wind directions	Scientific planning was done	Scientific investigation conducted through experiment	No data evaluation and communication of findings	Good learner participation	No data collection but LO 1 was focus

Table 4.27: Summary of second observed lesson presentations

Partici-pants	Gr	Topic	Planning scientific investigations (focus question)	Conducting scientific investigations and data collection	Evaluation data and communicating the findings	Type of Assessment and tool used	Introduction
P2	6	Energy and change	No knowledge of scientific planning	Scientific investigation not conducted	No data evaluation and communication of findings	Good learner participation	Educator achieved LO 2 and LO 3 not LO 1
P4	7	Solar system (earth position)	No knowledge of scientific planning	Scientific investigation not conducted	No data evaluation and communication of findings	Good learner participation	Educator achieved LO 2 and LO 3 not LO 1
P5	4	Moving air; temperature; weather condition	Planning was done by the educator	No scientific investigation conducted	No data collection	Learner participation good	Educator introduced his lesson well
P6	4	matter and its characteristics	From the observation it appeared as if the teacher had no knowledge of how planning had to be done	No scientific investigation conducted	No data collection	Learner participation good	More of LO 2 and LO 3 was addressed that LO 1

Table 4.28: Summary of third observed lesson presentations

Partici-pants	Gr	Topic	Planning scientific investigations (focus question)	Conducting scientific investigations and data collection	Evaluation data and communicating the findings	Type of Assessment and tool used	Introduction
P4	7	Solar system (earth position)	No knowledge of scientific planning	Scientific investigation not conducted	No data evaluation and communication of findings	Good learner participation	Educator achieved LO 2 and LO 3 not LO 1
P5	4	Cardinal points-wind directions	No knowledge of scientific planning	Scientific investigation not conducted	No data evaluation and communication of findings	Good learner participation	Educator achieved LO 2 and LO 3 not LO 1
P6	6	Stars	Planning was done by the educator	No scientific investigation conducted	No data collection	Learner participation good	Educator introduced his lesson well

4.4.2 Observations

Observations were conducted in six different schools with 13 educators who participated in the interviews. The results for the observations and document analysis are shown above on Tables 4.26 to 4.28. The aim of conducting observations was to confirm or contradict the opinions educators gave during interviews. It has been evident that some educators have an idea on how to conduct scientific investigations but to put these investigations into practice was problematic. The ideas they shared during interviews did not relate to their practice. If theory is not applied in practice, that theory is useless. Tiley (in Ramoroka 2006:98) argues that theory without practice is sterile and practice without theory is blind. This means that if one person knows how something should be done, that knowledge should be applied in practice. Theory helps one to change a way of thinking and, will affect the way of doing things.

I have realised that the lessons designed by educators stated that they are going to present LO 1: Scientific Investigations and indicating the assessment standards well as (1) Planning investigation, (2) Conducting scientific investigations and collecting data, (3) Data evaluation and communicating the findings, but during their delivery they change to LO 2: Constructing Science Knowledge and LO 3: Science, Society and Environment. Learners participated orally and chorally more often but their participation was satisfactorily. Assessment was mostly done orally although some grades did write the naming, categorizing, mentioning and explaining questions which are more of scientific knowledge than scientific investigation.

All participants tried their best although in their planning, the integration of assessment standards was not explicit. In one lesson learners were requested to collect the leaves, compare and classify their shapes (scientific investigation and data collection was done) but there was no data evaluation and communication of the findings. The educator displayed little understanding because the data collected was never evaluated and the findings were not communicated to the learners as well. The topic required a particular class only to collect leaves, compare and classify their shapes not all other classes. The 1st table depicts the 1st lessons observed by the researcher on a particular day and time. The 2nd table shows the results of the 2nd session of the same educators observed, teaching different topics on particular date and time. The 3rd table shows the 3rd lessons observed by the researcher presented by the same participants trying to check if the participants are given the different strands and topics they would give the results.

Direct instruction still dominates in the classroom, though some educators use group work. Tiley (in Ramoroka 2006:100) argues that learners need to sit so that they can talk to and work with each other in groups. Many learners in the classrooms (especially overcrowded classrooms), as observed, sit in a row and face the educator. In such a classroom setting, direct instruction dominates as an instructional offering. There is no evidence that learners were engaged in different learning activities.

4.4.3 Document Analysis

In addition to interviews and observations, document analysis was also conducted. Annexure C shows the records that educators keep. Many educators keep the following records: lesson plans which do not address scientific investigation, tests and memoranda which only assess the memorization of facts, mainly addressing LO 2 (creating scientific Knowledge), books and mark sheets which recorded marks for tests and assignments. Most lesson plans are not up to date. Educators do not follow their lesson plans because when designing their lesson plans, they write that they are going to conduct scientific investigations and indicate the correct assessment standard but during their presentation they turn to direct instructional teaching. More evidence is depicted on their observed lessons (Annexure B) and CDs. Educators do not have analytic rubric which is used to assess the project or practical tests or experiments. According to their performance as they conduct scientific investigations, collect data, analyse data and communicate findings. Most questions are testing knowledge even if it is written scientific investigations on their questions.

The records of marks that teachers keep are clear to inform the parents and other users about progress of learners. Educators should design the rubric for assessment indicating the integrated assessment standards and allocate the marks for each assessment standard. For example, if a learner is able to plan a scientific investigation, conduct a scientific investigation and collecting data, evaluate data and communicate the findings should be given full credits and in that way one can confirm that the learners are able to integrate the assessment standards. The same rubric was used to assess educators. Annexure A shows educatorôs rubric used by the researcher. Clear records can inform the stakeholders about learnerôs performances and about the effectiveness of instructional and assessment strategies followed in the classroom. These can be used in formative assessments when learners are given feedback and formative purposes where their level of performance is judged.

4.5 CONCLUSION

In this chapter, data were analysed. Qualitative data collection methods were followed in this investigation. The chosen data collection methods were interviews, observations, and document analysis. To simplify analysing data, interview transcripts were coded.

Educators do not have knowledge of the scientific investigations and as such they cannot put any theory into practice. What most of them say they know about scientific investigation during interview does not concur with what they practise in the classroom. During interviews, some educators have given important points to show their understanding of a scientific investigation but when they were required to put that in practice, it became problematic.

(Table 4.10 Interview response) Almost all participants did not have focus questions in their lessons which were observed (Annexure B and CD).

Learners should be assessed continuously when conducting scientific investigations and their performances be recorded and be kept in educatorǿs file. Tiley (in Ramoroka 2006:102) states that, the basic elements of continuous assessment are observations, recording and reporting. Many educators still have a problem with continuous assessment. If educators have a problem of recording when they assess learnersô work, there will be no evidence of learner performance. Without keeping records of learnersô performance, it will be difficult to report on how learners perform.

In the next chapter, conclusion of the investigation is drawn where the purpose of research was to discover educators understanding of the NCS policy and integration of the assessment standards in Natural Sciences when conducting scientific investigation in the Intermediate Phase. The interviews, observations, document analysis and reviewed sources assisted the researcher to come up with the recommendations.

CHAPTER 5
DISCUSSIONS, CONCLUSIONS, RECOMMENDATIONS AND IMPLEMENTATIONS

5.1 INTRODUCTION

The aim of this final chapter is to provide the reader with a discussion of the findings of the investigation. The reader will therefore be supplied with information regarding the main findings of the investigation according to the literature and empirical data. The main findings are discussed in terms of how they respond to the main research question and the supporting questions. The results of the investigation may be relevant to the Mankweng area but could also be relevant to the other parts of the country.

5.2 RESEARCH PROBLEM, RESEARCH QUESTIONS, AIM AND OBJECTIVES OF THE STUDY

5.2.1 Research Problem

The main research problem was to investigate how educators interpret and integrate the assessment standards when conducting scientific investigations in the Intermediate Phase. In the past, prior 1994, educators were teaching General Science in the senior primary schools. After 1994, General Science was changed to Natural Sciences when OBE was introduced in the South African Education system. Educators have followed direct instruction for a long time in their instructional practices when teaching General Sciences, and in most cases they assessed learner performance through written work. This was done at the end of the lesson, or at the end of the month, a quarter or a year. In short, they followed summative assessment which was norm-referenced (Ramoroka, 2006).

In Chapter 1, I stated that when OBE and the NCS were introduced into the South African education system educators were expected to change their ways of teaching and assessment. Despite the introduction of the new curriculum (NCS), it appears that nothing much has changed in our classrooms (Meiring, Webb, Isle & Kump, 2005). The three learning outcomes in the NCS policy Natural Sciences are similar to the three specific aims now outlined in the CAPS. As the researcher, I argue that if educators are not well trained to implement CAPS, problems with the learner achievement will be experienced.

The National Curriculum Statement (2002: 3) Grades R-9 schools policy for Natural Sciences inform educators on how to conduct scientific investigations, states the competency expected of educators and how to integrate the process skills during lesson designed, presented and assessed. The assessment guideline document (DoE, 2010) which is used with the NCS policy (2002:13-14) shows the process skills which should be part of the preparation (lesson design) and facilitation (presentation) of the lesson and assessment thereof. These process skills include observing and comparing, measuring, recording information, interpreting information and hypothesising to name but few. The educatorsô preparation (lesson plan) lists LO 1: Scientific Investigations and relevant assessment benchmark as scientific inquiry plan, managing inquiry and data collection, weighing data and collaboration the solution. But contrary to what they have planned, they start describing, naming, defining concepts which are mostly used when addressing LO 2 (Constructing Scientific Knowledge).

Educators have to fulfil various roles outlined by original norms and standard in the NCS (National Curriculum Statement) policy (DoE, 2002:3) Grades R-9 (schools) wherein seven responsibilities which must be accomplished by teachers. The responsibilities comprises of being intermediary of learning, translators and makers of learning curriculum and resources, heads, officers and supervisors, researchers, academics and all-time learners, communal members, society and priests, advisors and subject experts. This investigation focused mainly on the following two roles for educators, as researchers and as well as makers of learning curriculum. If educators were able to conduct Scientific Investigations (LO: 1) well, they would be able to satisfy the two roles completely but the opposite was witnessed during observation of the prepared lessons and presentation as well as during conducted interviews. (DoE, 2002:3).

Inquiry is the essential experience of science, yet according to Windschitl (2001:113), the immeasurable mass of newly appointee science educators (employed educators who have recently earned their teaching qualification) become educators lacking experience to perform a lone research in which they initiated a researchable request and creating the exploration to respond to that request. Educators` perceptive might impact on how they understand their personal knowledge and thinks that the research they perform alone, the links between their practices, trusts and instructional methods for the study, and technique used to bestow in laboratories (Windschitl, 2001).

Both educators and learners are expected to interpret and integrate assessment standards when conducting scientific investigations well in order to become competent lifelong researchers. Mokhaba (in Ramoroka, 2006) believes that because assessment serves different purposes, different methods should be used to assess learner progress.

Teaching and assessment approaches followed in the traditional teaching of General Sciences are applied as well in the NCS policy depending on the problem to be solved. Teaching and assessment approaches in General Sciences are referred to as process skills in the NCS policy. This investigation focused mainly on educator`s understanding of scientific investigations which is vital towards the production of future scientific researchers.

5.2.2 Aim of the Investigation

The aim of this investigation was to explore educatorsô interpretation and integration of the assessment standards when conducting scientific investigations in the Intermediate Phase. This was achieved by conducting interviews, classroom observations and document analysis for all the educators involved in this investigation. It was clear that most educators in this study could not interpret the NCS policy, let alone integrate the assessment standards when conducting scientific investigations and assess the learnersô for progression using the relevant tools like a rubric.

This confirms that educators have little or no understanding of how to interpret, integrate the assessment standards and to assess learners for progression. The researcher supports Killen (in Ramoroka 2006) when he states that understanding is the capacity to use explanatory concepts creatively. Educators should conduct scientific investigations monthly; however, Ekborg (2005:1688) concluded that majority of anew educators cannot create the theoretical perceptive needed to involve through the social and research cases they come across.

In their study, Jarvis, Pell and McKeon (2003:17) discovered that numerous educators have relinquished distinctive delusions that have been recognised previously; regardless the interchanges primary educators` subject matter. Educators too developed an insignificant knowledge of variables and their management throughout an annual training program on emerging and weigh up inquiries.

During this investigation, it was clear that many educators still cling to the traditional approach of teaching. There are no significant changes in the way they teach and assess learners. Ramoroka (2006) claims that not all educators have the necessary experience and creative abilities to generate a large number of innovative ideas; this means that some educators do not have experience to plan and conduct a scientific investigation. They do not choose a confirmatory experiment available in some textbooks to perform in the classroom.

If they had knowledge of how to conduct a scientific investigation, they could have performed simple experiments with a simple focus question.

5.2.3 Objectives of the Investigation

The **first objective** of the investigation was to have a better understanding of the NCS policy on the definition, unique features and scope of the Natural Sciences (LO: 1) Scientific Investigations and their assessment standards.

According to Roehrig and Luft (in Ekborg 2005:1689), aspects like subject matter, opinions on the features of science, lecturing theories and educational understanding are depicted in a cooperative way by research (see also Shulman, 1986) (see Chapter 1 Section 1.7.1).

The **second and third objectives were** to determine how educators design scientific investigations, integrate them with assessment standards and implement them in the classroom situation, their lesson tasks (lesson plans to use the old definition) and teach scientific investigations in terms of the assessment standards. It was clear from the study conducted by Jarvis et al. (2003:18) that educators want a full comprehensive perception of the interconnected theories outside the request of the national core curriculum, as deprived of it they may well grow delusions that could obstruct with learners perception and endorsement that job-related teaching wants to be uninterrupted above a significant span of period, to allow wholly educators to extent a scientific perception deprive of which there is a danger that they would endure to acquire delusions (see Chapter 1 Section 1.8.1).

According to Wong and Hodson (2008:119) readily available, there is a vigorous interrelatedness of science and know-how skill subject (technology). Learners frequently reason that ñscience comes after technologyò and proceeds in science, carry out advances in technology and technology motivates advancement in science.

In addition to interviews, classroom observations and document analysis were conducted with educators. Educators were also observed in practice and their document analysed. During investigation it was apparent that educators have little or no understanding of how to interpret, integrate assessment standards when conducting scientific investigations and how to assess learners for progression using relevant tools like an assessment rubric. During interviews, some educators stated that they have designed/planned scientific investigation lessons, taught them to their learners but when submitted to me for analysis, there seemed to be no integration of the assessment standards.

If educators understand NCS policy for Natural Sciences in the Intermediate Phase well, learners would be able to conduct simple investigations, let alone confirmatory experiments.

The **fourth objective** was to find out how educators assessed learner performance in the classroom when conducting scientific investigations and how do they keep records of their work and the feedback they gave in the learnersô books. How educators manage assessment records, will reflect their understanding of NCS policy. This was achieved through document analysis of educatorsô records. The way in which educators keep records should reflect their understanding of NCS policy.

Liu, Lee, Hostetter and Linn (2008:35) argued that there is a demand for sound science assessment. They developed an underlying construct named information combination as an active portion of scientific research. Information combination evaluation request learners to connect, differentiate, assess and categorise their views about complicated scientific topics (see Chapter 2 Section 2.5).

Educatorsô understanding plays a major role in the production of scientific researchers in future. In their records there were only marks for monthly tests, assignments to say the least, only written work was recorded. According to Liu et al (2008:52) researchers like Black and Wiliam (1998) have named for an extra reasonable evaluation framework. Educatorsô interpretation and integration of the assessment standards should assist them in modelling instruction; giving problem-solving to educators, demonstrating complicated thinking, and encouraging numerous problem-solving skills. However, challenges to developing such a framework with relevant assessment standards located in numerous pleats: shortage of intellectual fundamentals, weakly explained theories, discontinuation between evaluation things and focus construct and overgeneralised recording rubric as they are countless (see Chapter 2 Section 2.5).

The educatorsô misinterpretation and disintegration would compromise the understanding of the outcomes, the effect of the conclusion and the confirmation of the assessments. Assessment supports the learning aim of constructing consistency through the collection of views rather than concentrating on disconnected ideas. Assessment improves the condition of complicated thinking in the schoolroom and motivates educators to boost analytical thinking during their curriculum application. Nevertheless, assessment confined to schoolroom must be planned and carried out to calculate the complicated scientific perspective while staying compactly associated with the teaching empowering the view that assessment encourages learning instead of scarcely showing learning (Black & Wiliam, 1998) (see Chapter 2 Section 2.5).

5.3 ALIGNING THE MAIN FINDINGS TO THE LITERATURE REVIEW

5.3.1 Meaning and Understanding of Scientific Investigations

According to Aschbacher and Roth (2002:41), Scientific Investigation involves a progression of discovering the natural or resourceful sphere that directs a request to probe and creating encounters in the quest for modern perspective. The inquiry-based method of science instruction had a lengthy past of growth in the USA and highlighted the up-to-dated science transformations (see American Association for the Advancement of Science (AAAS), 1993 and National Research Council (NRC) 1996) (See Chapter 2 Section 2.1).

Luke (in Conana 2009:4) defines a Scientific Investigation as: ñAn open-ended action that integrates science theory within the science discipline in order to encourage higher-order thinkingò. Hattingh, Aldous and Rogan (2007:77) refer to a scientific investigation:

> *"As an open-ended task, representative of sophisticated learner-centred activity, they classified these tasks into four levels of complexity from 1-4 in science practical work".*

In conclusion, Roberts (in Conana 2009) sees a Scientific Investigation as a way of showing how experimental science has its roots in a careful, concept-driven view of the real world. Murray and Reiss (in Conana 2009) states that when learners are involved in a scientific investigation, therefore, they gain an insight into what science is all about and the same sentiment was shared by Murphy and Beggs (in Conana, 2009). Morrison (in Conana, 2009:5) stated that scientific investigations also help to show learners how they can develop their knowledge and skills by using apparatus (see Chapter 2 Section 2.2)

But in this study, it is evident that educators who participated in this study do not understand how to conduct Scientific Investigations (LO 1) and they do not know how to teach Scientific Investigations (LO 1) to the learners. Therefore it will be difficult for learners to perform well hence educators are struggling. Instead, they plan their work, design the investigation, record their results and draw their own conclusions. In addition, Richardson (in Conana 2009) states that learners do not copy work from the chalkboard and try to understand it later.

It is vital that the kind of assessment utilized must correspond with the outcomes to be evaluated. Or else the assessment might not be valid (not gauge what it was invented to gauge). Like educators must not attempt to gauge scientific hands-on ability by putting a pencil on paper task. The type of assessment must match the goal of the evaluation.

In this investigation, all educators participated wrote LO1: Scientific Investigations on their lesson designed and the assessment standard but no one knew the definition as stated by the policy (DoE, 2002). The policy further expands on these outcomes by giving three assessment benchmarks:

- Scientific inquiry plan
- Performing an inquiry and data collection,
- Weigh up data and conveying the solution (DoE, 2002:16) (see Chapter 2 Section 2.2)

5.3.2 Planning Scientific Investigations

According to Ferrance (2000:10) educators sometimes have numerous questions they like to explore, though it is vital to reduce the questions to single one which is significant and achievable limited to a single day work. Cautious preparation at this point reduces the untrue beginning and hindrances. There are numerous principles to check before inquiring the period and strengths in ñresearchingò a problem.

Ferrance (2000:10) suggests that before embarking on a scientific investigation, there must be planning which needs to be guided by questions. The questions should include higher order questioning to develop critical thinking but they need to be stated clearly and be brief enough and frame in simple enough language for the learners to understand. The scientific question should be valuable and be aligned to the curriculum.

Ferrance (2000:11) further insists that the following questions should be answered before data collection commences: (1) Are the data simple to gather? (2) Are resources immediately accessible? (3) How organised and logical would the collection be? (3) The use of three resources (triangulation) of data for the core of the movements is mentioned (See Chapter 2 Section 2.2.1 and Table 4.10)

According to Edelson, Gordin and Pea (1999) enquiry capabilities can give treasured prospects for learners to develop their knowledge of both science subject matter and scientific exercises. Furthermore, research tasks give treasured subject matter for students to obtain, simplify and affect knowledge of science hypotheses. Edelson et al. (1999) define investigation as the quest of open questions, which is a fundamental to the practice of science. The participants in this study did not have a focus question on the lessons designed and during presentation. Tables 4.10 - 4.11 and Annexure C bear testimony to the above statement.

The view promoted by Dewey (in Edelson et al., 1999) is that Scientific Investigation knowledge is grounded on the view that science knowledge must be faithful to science practice. Genuine tasks give students with the inspiration to gain new experience, an understanding to relate their perspective. An investigation is lively, in divergence to the learning. Investigation as a trustworthy exercise also gives a treasurable perspective for scientific learning.

Fuchs (2005:49) explains that scientists also ask questions to get answers, but they must ask their questions in ways that can be tested through scientific investigations. This means that some questions are more easily answered than others. Students should learn how to ask questions in the ways that scientists do. Each question should define a general problem. Students should acknowledge questions which are not appropriate for a scientific investigation because they involve personal preference and moral values. However, sometimes questions are appropriate to scientific investigation but need to be rephrased in a more specific form. Scientists recognise two primary types of questions as stated by Fuchs (2005:24) which involves why ñexistence questioningò or how ñcausal questioningò. Educators should be guided by both types of questions but should ensure that causal questioning is predominantly used in scientific investigations (see Chapter 2 Section 2.2.1)

Certain types of investigation have been discovered by professional academics embracing well-order demonstrating investigation, amalgamation of elementary sources and evaluation of quantitative data. Every type of inquiry has its personal method and competency. Research can provide to the improvement of science subject matter knowledge in everything which follows: predicament, exigency, find, improve and operate (Edelson et al., 1999).

The participants in this investigation need to be work shopped intensively by knowledgeable curriculum advisors understand the significance of authentic inquiry and learn the opportunities for learning through Scientific Inquiry, which they then will be able to transfer that knowledge to their learners.

5.3.3 Conducting Scientific Investigations and Data Collection

Schwab (in Trumbull, Bonney and Grudens-Schuck 2005:880) (see Chapter 2 Section 2.2.1) discouraged that science be offered to learners as a firm body of intellectual information, cast down learners from coming up with their own discoveries and accounts of their experiential trends. Non-existence of expertise with scientific investigations reduces the achievement with which learners assess scientific statements. Alternatively, if learners are developed with reliable prospects to operate and lead scientific investigations that will empower their competency to productively appraise the difficult scientific views.

DeBoer (in Trumbull et al., 2005:880) monitored that unique changes produced diverse perception of the part of research in science education as well as unique perception of suitable education tactics for gathering research objectives. Research laboratory is a suitable place commonly well-thought-out to advance chances for learners to acquire competency about research. DeBoer (in Trumbull et al., 2005:883) supported by the following researchers (Germann et al., 1996; Herron, 1971; Tamir & Lunetta, 1998; Scwab, 1962) (see Chapter 2 Section 2.2.2)

> *"One might therefore expect reform efforts to have generated a range of laboratory-based activities that successfully involved students' inquiry. Laboratory exercises typically used in schools continue to emphasise confirmatory exercises that require students to follow explicit procedures to arrive at the expected conclusions. Students thus are rewarded for following directions and for obtaining predetermined correct answers. Consequently, students fail to learn habits necessary for conducting Scientific Inquiry, such as observation carefully, using theory and observations to formulate hypothesis systematically, analysing and interpreting data or other aspects of investigations"*

Ferrance (2000:11) further insists that the following questions should be answered before data collection commences: (1) Are the data simple to gather? (2) Are resources immediately accessible? (3) How organised and logical would the collection be? (3) The use of three resources (triangulation) of data for the core of the movements is mentioned. Ferrance (2000) however, warns about selecting the data that are most appropriate for the issue being researched.

Sandler (in Conana, 2009:48) states that data are fundamental to scientific investigations and by the time learners reach high school, they should be well prepared to collect and interpret data. ñHow will you collect and record your dataò is the question every researcher should ask himself/herself when planning a scientific investigation. Learners should be able to identify and collect data and all the trends to collect data are recognised insightfully.

These trends permit the learners to plan the best way to record their results once they have collected them such as tabling the results, drawing graphs, explaining in paragraphs or describing the results and drawing diagrams that show in proportion a comparison of one thing to another (see Chapter 2, Section 2.2.2)

5.3.4 Evaluating Data and Communicating Findings

Fuchs (2005:25) explains that learners should learn that scientists communicate their findings in a way that other scientists may try to replicate their effort. Duplication gives science with a vital means of transportation for excellence management. Other academics of the other hand could utilize the outcome to research new but with relation to the request. Learners as well, profit by sharing their outcomes with their peers in class (see Chapter 2 Section 2.2.3).

Ferrance (2000:12) argued that as the quest under research directs, educators might like to utilise the classroom data, self-generated data, or mini group data, whichever is relevant and utmost suitable. The quantified data might not be analysed without the utilisation of statistics or practical support whereas other data, like views, feeling, or checklists, maybe sum up in table style. Unquantifiable data could be revised as a whole and of significant elements or themes can be identified (see Chapter 2 Section 2.2.3).

5.4 MAIN FINDINGS OF THE EMPIRICAL INVESTIGATION: INTERVIEWS, OBSERVATIONS AND EDUCATORS' RECORDS

The following segment offers the principal conclusions of the research and tries to despatch every research question established for this research.

5.4.1 Research Question 1

How do the NCS and the assessment policy inform educators on how to conduct a scientific investigation in the Intermediate Phase?

As explained in Chapter 2 Section 2.6.1, all teachers are major providers to the change of curriculum in South Africa.

The Revised National Curriculum Statement Grades R-9 (schools) foresees educators who are trained, skilled, committed, and devoted and be able to carry out different characters sketched out in the Norms and Standards for Educators. These characters embrace being facilitators of learning, translators, planners of learning schedules and resources, managers, governors, officials, overseers, academics, intellectuals, specialists, communal member, civic member, priest, evaluators, learning area experts.

In this study, I focused on the following characters: facilitators of learning, translators and planners of learning schedules and resources managers, governors, officials, overseers, academics, intellectuals, specialists and the kind of teacher envisaged by NCS policy (DoE, 2002:3). Scientific investigations expect learners to be able to do things assertively on inquisitiveness about environmental occurrences, and explore connections as well as resolving difficulties in scientific, technical and conservational frameworks. Currently, Revised National Statement, advancement is shown not only in terms of the information a student can remember. Some Learning Outcomes 1, 2, and 3 are manipulated to evaluate development in studentôs capabilities to design and conduct an inquiry including information, and the competency to translate and implement that information in the schoolroom circumstances involving the students as an associate of a transforming citizens (DoE, 2002:7).

When asked by the researcher about strategies which are to be followed when conducting scientific investigations: Participant 1 responded:

> *"…Ok, when conducting scientific investigation, sometimes we use... (Pause)*

[She couldnǿt answer. She threw the tippex on the table. The question was repeated twice]. The response by Participant 1 showed that the educator did not know the strategies or the assessment standards to be integrated when conducting scientific investigations. She could not answer the question fairly well even after it was repeated.

When asked by the researcher about the number of variables which are to be measured when conducting (confirmatory experiment) scientific investigations: Participant 8 responded:

> *"It was a confirmatory experiment.*

Participant 8 did not give answer to the question asked. It is assumed that the participant did not know any of the variables in the confirmatory experiment she performed to the learners.

When asked by the researcher about teaching learners on data evaluation, Participant 10 said:

> *"(Err) learners must follow the data to the answer…data must lead learners to the answer."*

When asked about how to teach learners evaluation of data, Participant 6 responded as follows:

> ñ*If I can evaluate the learner by giving them the graph during January for rainfall if inconsistent data results I will through them away"*

Participant 6 is giving example of January month for rainfall but is not giving clear steps for learners to understand how to evaluate data in a scientific investigation.

When asked about teaching learners how to evaluate data, Participant 11 responded as follows:

> *"(Err) data collected will be evaluated in the form of giving learners some tasks."*

Participant 11 is not answering the question asked; therefore she does not have an idea of teaching learners how to evaluate data when conduct scientific investigation.

When asked about the sources of data which are readily available to educators and learners, Participant 5 said:

> *"Sources, preferably we will rely on learners' textbooks, educators (Err) educators' books, some resources relevant to the topic of the day or situation it will depend on the type of the topic."*

It seems that Participant 5 did not know the sources of data readily available to the educators and learners as well.

When asked about assessment strategies to be followed when conducting scientific investigation, Participant 9 said:

> ñ*When they do research, usually it interviews they will interview people, they will search for information from library and from the surrounding and the community".*

The participant 9 confuses the assessment strategies with data collection instrument such as interview. The educator does not know the answer to the question asked therefore I think she lacks knowledge on scientific investigation.

When asked how to make sure that the focus question is researchable than been answered by a ñyes or noò, Participant 3 said:

> *"The question can...there is no need for them, "yes or no" because learners can explain everything which they have done, because they will explain step by step about the information and the method when conducting that research."*

Participant 3, it seems did not know how to formulate the good researchable question.

In enquiring about resources to be used when conducting scientific investigation, Participant 4 responded as follows:

> *"(Err) the resources that can be used (the) I think knowledge is one of the best of the science before you can go much further and promotion of it even to develop more especially in the society".*

Participant 4 did not know the resources to be used when conducting scientific investigation but he made mention of knowledge as one of the best resource in science, but she was not answering the question.

In enquiring about assessment strategies when conducting scientific investigation, Participant 12 responded as follows:

> *"I think this involves about it involves planning and investigation, conducting a research and at the end evaluation."*

Participant 12 shows an understanding of what is required of him but the last part of his answer is incorrect.

When asked about teaching data evaluation to learners, Participant 13 responded as follows:

> ñ*you can evaluate data through measurement you can see if you have done like for example during the lesson to see that learners are really following what I was supposed to be doing was just to give them to observe the plant the real plant and they can they were supposed to feel the leaves almost each and every time may everyday they could feel so that they see day by day so and so such and such a plant is dying or it can die at any time."*

The response given by Participant 13 is very long and ambiguous too. It shows that the participant is pulling from pillar to post trying to get the correct answer but unfortunately the answer is not correct. To him data evaluation is like lesson evaluation at the end of teaching learners.

Research done by Skamp (1992) and Trumper (1998) have indicated that elementary educators schooling have very restricted science perspective and they as well hated science particularly one of the ñhard sciencesò physical sciences and this in turn, tends to have an effect on the attitude of the learners towards science.

But the educators interviewed, observed in practice and whose document analysed do not fulfil the various roles outlined by Norms and Standards for educators outlined above. The implication here is that a policy can be good but difficult to implement. Some educators interviewed did not follow the policy document during their classroom practices. During interviews one participant (P12) (see Table 4.5) responded that there are three strands to be taught on the NCS policy for Natural Sciences in the Intermediate Phase.

To give an example of how teachers found it difficult to come to terms with the use of focus questions (which is part on a scientific investigation) to drive the research, I specifically requested the participants to indicate the purpose of a focus question when conducting scientific investigations. Participant 1 responded as follows:

> *"… (Umm) when conducting scientific, I think (umm) or maybe I can say, in the lesson". [Video camera was stopped, because the educator was struggling to answer].*

The question was repeated and the participant 1 responded as follows:

> *"My focus question, in the lesson, (umm) in the food chain. I, (I) will put it in such a way that everything is important in their particular area is there to do work. They will have to know, or how..."* (She failed to complete the sentence).

When the same question on the importance of a focus question was asked, Participant 7 responded like this:

> *".... (Pause), they may do observation, ask them to observe, they seem to understand much better, describe what they observe."*

The above mentioned responses confirm my opinion that educators lack experience when it comes to conducting scientific investigations and for this reason found it difficult to provide clear answers to a reasonable simple question.

From the evidence collected, it also appeared as if some educators also experienced difficulty in understanding when, why and where scientific investigations have to be conducted. For example, I needed to understand if educators knew when and where to conduct scientific investigations. Participant 4 replied as follows:

> *"... (Err) when we understand the matter and when we want to improve the other methods of scientific investigation then it will depend on the progress sometimes on the research project."*

The same question regarding where and when to conduct scientific investigation was asked of Participant 7 who responded as follows:

> *"If the strand that you are teaching requires a research and then you must conduct it."*

Participant 4 above could not tell where and when to conduct a scientific investigation, but he spoke about methods and research project. The same difficulty was experienced by Participant 7 when asked about where and when to conduct a scientific investigation, responded by saying if the strand require it he would conduct it. Participant 7 is not answering the question because he did not know that research could be conducted anywhere and anytime if you had a focus question.

Shapiro (1996) in a research performed with fundamental science procedures classroom discovered that 90% of her learners had on no occasion faced science as a research. This observation applied specifically to those students who had attended school science fairs. Educators` conceptions in scientific inquiry can be influenced by beliefs about inquiry, by working in laboratory settings, and by coursework in teacher education (see Chapter 2, Section 2.7.3).

Educatorsô conceptions in scientific inquiry can be influenced by beliefs about inquiry: to work in laboratory settings and by coursework in teacher education. According to Kennison (1990) these know-hows provide forthcoming educators with rational sculpts of teaching which they utilise to envisaged lessons in their individual schoolrooms, acquire improvements, and learning results. Educators are with a reduction of probable to be directed by instructional philosophies than by acquainted pictures of what is ñproper and possibleò in schoolroom sceneries (Russell, 1993; Zeichner &Tabachnick, 1981) (see Chapter 2 Section 2.7.3).

The focus of my study was to investigate whether the educators teaching Natural Sciences in the Intermediate Phase are as envisaged by the NCS policy (DoE, 2002:3) as educators who are interpreters and designers of the learning programmes as well as researchers and lifelong learners. Annexure A (scores on the observation- Part 1 and 2) is the reference. During lesson observations, the researcher observed that almost all participants could not pose a researchable/focus question to the learners except the participant (P8).

Furthermore, evidence is on Annexure B on the recorded lessons transcripts, Annexure C (Interviews transcripts) and Annexure D (scanned lesson plans). Because almost all participants could not interpret the NCS policy well, they could not as well design a good lesson for Scientific Investigations (LO: 1). Almost all participants are not researchers as well because they could not define, plan, conduct, collect data and communicate the findings. The last but one point is that they are not presently enrolled with any university for personal development (not lifelong learners) except participant (P8) who is a Masters student at one of the renowned university in South Africa.

Lastly, with reference to table 4.2 on background knowledge check, the researcher established that almost all participants did not do physical science as a major subject at least at matriculation or grade 12, therefore scientific investigation was foreign to them.

5.4.2 Research Question 2

How do educators interpret the NCS and assessment policy that inform them on the attainment of the assessment standards when conducting scientific investigation?

This research question was answered during interviews when participants responded to the questions regarding the general knowledge of the NCS policy, time allocated for each strands, number of strands in Natural Sciences, time spread amongst the three learning areas as well as the number of periods per week. During the investigation, it became apparent that educators know very little about the NCS policy.

Educators gave good opinions regarding the NCS policy in general but as for integrating assessment standards when conducting scientific investigations it was a serious problem. When they were asked about a focus question during the interview, most of them were lost. The researcher had to give examples of focus questions to participants before they tried to answer.

According Wu and Krajcik (2005) if educators are able to understand the inscriptions like tables, graphs and use them well, studentsô interpretation would improve as well as their scientific skills. Kruger et al. (in Jarvis et al., 2003:40) write:

> *"It is difficult to see how a teacher can give children appropriate experiences which enable them to acquire a progressive understanding of science concepts unless the teacher knows and understands what lies at the end of this conceptual development".*

In their study, Jarvis, Pell and McKeon (2003:17) discovered that numerous educators quit have distinctive delusions that have been recognised previously; regardless the interchanges primary educators` subject matter. Educators too developed an insignificant knowledge of variables and their management throughout an annual training program on emerging and weigh up inquiries (see Chapter 1, Section 1.7)

Participant 4 was asked about the focus question when conducting a scientific investigation and responded as follows:

> *"(Err) when you conduct, the learning outcome number one LO 1: scientific investigation, one will be achieving the LO 2- Constructing Science Knowledge."*

Participant 5 responded as follows when asked the same question:

> *(Pause)" yes, it can base on (err) introduction on science knowledge according to the level of these learners."*

Participant 7 answered as follows when asked the very same question on focus question:

> *"(Pause), they may do observation, ask them to observe, they seem to understand much better, describe what they observe."*

Participant 9 responded as follows after been asked the similar question:

> *"The focus question, I think is the main. Main (err) objective of the lesson, of the investigation."*

Participant 13 replied like this when asked about the focus question in scientific investigation:

> *"In this case you present a problem as I indicated in science you just present the problem and then learners will start thinking about how to do a research. What is it? What is the problem? Shall resources be needed during presentation?*

When the question on where and when to conduct a scientific investigation was posed: Participant 12 answered as follows:

> *"This can be conducted when there is I can say when learners are not aware of certain things that are highly scientific that they are supposed to do."*

The same question on where and when to conduct scientific investigation and Participant 11 responded as follows:

> *"… (Err) I do conduct a scientific investigation checking on the LOs and topics of that term."*

The seven (7) participants (P4, P5, P7, P9, P11, P12 and P13) responded differently to the same question about a focus question guiding the research. Participant 4 spoke about Constructing Science Knowledge (LO: 2) which is correct but the focus question relates directly with LO 1: Scientific Investigations. Participant 5 did not answer the question asked but spoke about introduction and science knowledge. Participant 7 and 9 as well expressed their different views. The same applied to Participant 13 who responded by stating the problem at the base. All seven (7) participants showed opinions or views of the importance of a focus question when conducting scientific investigations. Participants (P11 and P12) also expressed their views about where and when to conduct scientific investigations which is generally a problem for almost all the participant in this study.

The study conducted by Jarvis et al. (2003:18) reveals that educators want a full comprehensive perception of the interconnected theories outside the request of the national core curriculum, as deprived of it they may well grow delusions that could obstruct with learners perception and endorsement that job-related teaching wants to be uninterrupted above a significant span of period, to allow wholly educators to extent a scientific perception deprive of which there is a danger that they would endure to acquire delusions (see Chapter 1 Section 1.7.1).

Teacher`s guide for development of learning programmes NCS for Natural Sciences grades (R-9) policy (2003:22) states that:

> ñ*Teaching is a competence in which you may get better and better over the years yet never say `Now I have arrived`. It is an illustration of how competence can grow without reaching an end-point"*

I totally disagree with the assertion above because if educators are not well trained by competent subject advisers they will never be skilful, qualified, interpreters and designers of correct lesson plans for LO 1: Scientific Investigations.

The above mentioned teacher`s guide directs educators on the selection of the learning outcome which is LO 1: Scientific Investigations in this study and subsequently the assessment standards which should be identified as planning an investigation, conducting and collecting data, evaluate data and communicate findings. Assessment should be planned to ensure that evidence is shown on how learners are doing against the assessment standards. Contrary to what is explained in the teacherõs guide, learners performance was not recorded showing how each learner is meeting each assessment standards.

Participants could not determine what exactly was to be assessed (i.e. concepts, application, skill) and could not develop assessment activities in a way that learners have a different way of showing their competence. Furthermore, in the participant`s files there was no rubric to assess projects, no observation sheet and no assessment sheet for practical work whereas the teacherõs guide expected educators to report on every learner`s performance and progress against the learning outcome (LO:1) Scientific Investigation in this study. In conclusion, the participations do not know and understand what is expected of them (refer to scanned lessons ï Annexure D and Annexure A ï Part 3). The participants could not assess the LO 1: Scientific Investigation well.

5.4.3 Research Question 3

How do educators integrate and teach scientific investigations in the Intermediate Phase and does this occur according to the required assessment standards?

This question was posed to educators during interview. It was very difficult to the participants as only two participants (P2 and P3) responded that the ñwhyò, ñhow longò, question should be part of the focus question.

Vandeyar and Killen (2003:122) explain that:

> *"when we attempt to define what we want students to learn, we may decide that understanding is the capacity to use explanatory concepts creatively, or the capacity to think logically, or capacity to tackle new problems, or the ability to re-interpret objective knowledge"* (see Chapter 1 Section 1.2)

This indicates that understanding influences practice and consequently, the interpretation of the LO 1: Scientific Investigations and the successful integration with the assessment standards will enhance learner attainment of the quality education as envisaged by the Department of Education (2002). But because educators do not understand how to interpret and integrate the assessment standards when conducting scientific investigations, the learners as well would not be able to re-interpret objective knowledge.

When asking Participant 1 how to plan a clear and concise plan said:

> *"When planning I have to put things in points, points that I am going to use. Whether is an investigation, I am going to put the points in such a way that I know when do this and then so that at the end we have (what, umm) and clear (what) concise plan."*

Participant 4 when asked how to plan an investigation and how to teach planning said:

> *"I relay most of the time with the RNCS and the learner is the ones that assessment standard that guide me to introduce my lesson."*

This response by Participant 4 showed that he did not understand how to plan for scientific investigations and how to teach that planning to learners.

Participant 5 responded to the same question asked above by saying:

> *"Investigation can be planned according to…to maybe the…the topic of interest, the topic I am interested in maybe I will plan according to resources that are needed."*

When asked about teaching planning for a scientific investigation, Participant 6 said:

> *"In my planning before any investigation, I must bring all the resources beforehand."*

Participant 10 was asked the question concerning the place and instrument to collect data and replied like this:

> *"It can be collected anywhere using the instrument".*

Participant 10 was aware that data collection needed an instrument but could not tell the researcher the name of the instrument to be used when collecting data and relevant places to collect data. The same question as above was asked Participant 9 and responded by saying:

> *"Even that one will depend on the lesson"*

Participant 9 responded by saying that a place and instrument to be used for data collection depends on the lesson.

When asked how to evaluate data, Participant 10 answered by saying:

> *(Err) learners must follow the data to the answer…data must lead learners to the answer.*

Participant 10 stated that data must lead learners to the answer. The responses by the participants (P1, P4, P5, P6, P9 and P10) showed that they have different views on how to interpret and integrate assessment standards when conducting scientific investigation.

The prevalence of this ñimplementation problemò provoked McLaughlin (in Weber, 2008:26) to research why schoolroom exercises are so difficult to transform. Mitchell and Koediger (in Weber, 2008:26) argued that:

> *"Previous effort at curriculum and instructional reform has fallen short partly because reformers neglected to consider the decision-making process of teachers".*

Schulman (in Weber 2008) states that intellectual methodology to reviewing syllabus transformation is premised on two suppositions. The first one, the schoolroom activities and manners of the educators are mainly formed by their feelings, verdict, and resolutions and secondly, the findings of the educator rational and verdict rendering, composed with setting in which they work, give a good perspective of why educators perform what they achieve in their schoolroom.

The same sentiments are shared by Borko, Livingston and Shavelson (1990) who explain that for educators to implement the curriculum successfully, they must understand the integration between learning outcomes and assessment standards using a particular content accordingly (see Chapter 2 Section 2.7.3).

According to Bosman (2006) no previous South African study has probed the state of Natural Sciences education at the Foundation Phase level by means of empirical investigation. But this researcher has stated that in order to effectively teach young learners, teachers should be equipped to convey this broad perspective on the nature of science, its underlying philosophies, and its relation to society and culture (Bosman, 2006). The empirical survey suggests that teachers do have an inclusive understanding of what science entails, and that they are likely to portray the multi-dimensional nature of science in their science teaching.

It ought to be a cause of real concern that many South African teachers may not be familiar with either the concept of process skills, or their development. This concern was supported by the survey data, indicating that the majority of the Foundation Phase teachers do not know what the process skills entail. Such teachers cannot effectively facilitate the process of investigation, resulting in the non-achievement of LO 1: Scientific Investigations. Proper teacher training, the survey indicated that 57% of the teachers are in need of more training (Bosman, 2006).

5.4.4 Research Question 4

How do educators assess the achievement of the learners in terms of scientific investigations and assessment standards?

Almost all participants in this study assessed learners through tests and assignment. The educators tested the knowledge only as there was no evidence in their files to show that practical skills, values and attitudes were tested. Assessment activities should be suitable customised to adjust the wants of all students, to embrace that knowledge obstruction to learning, or who have inadequate materials (DoE, 2002:25).

According to the systematic evaluation survey study conducted by the Department of Education in 2004 to assess the achievement of the anticipated skills, knowledge, values and attitudes (SKVAs) in grade 6, its aim was to identify the areas which need improvement. The study provided vital information on learner attainment of important capabilities in Natural Sciences (DoE, 2005: 2).

The purpose of the study was amongst other things to:

- Provide some *"Tips for teaching*ò that educators could attempt in their schoolrooms to tackle the same difficulties amongst learners.
- The overall performance in Natural Sciences was low. The national average score was 41%. Generally, learners were not able to:
- Use meaningful words or sentences to interpret information given in graphical form.
- Relate observations that are reported from completed investigations to given focus questions for such investigations (DoE, 2005: 2).

All the three (3) learning outcomes were assessed during the survey. The findings were that learners obtained 50%, highest average score in LO 3: Science, Society and Environment, 39% in LO 2: Constructing Science Knowledge and 35%, which is the lowest average score in LO 1: Scientific Investigations (DoE, 2005:34). As the researcher, I think the survey yielded the valid results and areas which needed improvement were undoubtedly identified as LO 1: Scientific investigations.

Unfortunately, nothing drastically was not done to develop educators teaching Natural Sciences in the Intermediate Phase since the release of the report, hence the quote ñ*Tips for teaching*ò.

The tasks assessed by participants were based on LO 2 (Construction of Scientific Knowledge) only. The Learning Outcome LO 1: Scientific Investigations can be assessed using the following forms of assessment:

- Investigation activities
- Projects
- Research
- Practical demonstration.

When asked about the records kept to promote learners, Participant 7 responded by saying:

> *"I use quarterly record sheet".*

Participant 9 responded to the same question as follows:

"I keep the files and their record sheet wherein I record their marks."

Participant 7 showed that learner progression was conducted quarterly and Participant 9 said those records sheets are used to capture marks. The NCS policy as quoted above stipulates the forms of assessment relevant to LO1: Scientific Investigations. During observations and document analysis, none of the above forms of assessment was used by a single participant. Assessment tools for recording learner achievement are vital and a variety of evaluation equipment can be utilized to register student attainment.

The utmost significant assessment equipment for Scientific Inquiry (LO 1) is checklists, scale, rubric, reflection sheet (with criteria) (Assessment guidelines for Natural Sciences Intermediate and Senior Phases (DoE, 2002: 22, 35). Only P2 made mention of the science expo projects. No evidence of the assessment tools in all the participants files as written above. The assessment tools found in the participants files were not relevant to assess (LO 1) scientific investigations (see Chapter 2 Section 2.6.4).

The participantǿs presentation lessons were observed and their lesson plan templates have been analysed. Thirteen lessons were taught by the participants involved in this study and observed by the researcher. Only two participants planned their scientific investigations but it did not teach learners how to plan a scientific investigation. Assessment was mostly oral and choral. Learnerǿs participation was averagely well. (Table 4.26 depicts the summary).

The researcher asked the participant whether integration of the assessment standard is explicit on the template used to design the lesson plan and Participant 9 responded as follows:

"Jar, I do, but sometimes you find that some do not integrate with any other assessment form.

The same question as above was asked Participant 6 and his response was*:*

"Yes, I use internal and external integration.

When asked by the researcher whether the integration of assessment standards is clearly indicated when designing a lesson plan and this is the response from Participant 1:

> *"Another one is on making a day and night using a torch, globe and learners could learn how days and night operates. In matter and material, we had three states of matter, we made the experiments, with the boiling water and then, from there they could see the water evaporating, they and the ice to prove that it was solid."*

Participant 1ǿs response was inappropriate and did not answer the question. Participant 6 spoke about internal and external integration which showed no understanding at all. Participant 9 also stated integration of assessment form which showed little or no understanding of the question asked. Almost all participants showed little or no understanding of scientific investigations because they most probably did not study physical science at secondary and tertiary institutions. Table 4.2 give evidence to this claim. Curriculum advisors work shopped educators for 3 or 4 days.

Curriculum advisors as well do not know how to teach educators the best ways of teaching learners how to conduct scientific investigation. Harlen and Halroyd (in Ekborg 2005:1674) stated that studies, focused on the primary school teachers who are not specialised in science, have shown that they hold similar misconceptions as their pupils in school (see paragraph 1.7). Lack of resources as highlighted by Participant P3 in (table 4.6), Participant P1, P2, P8, and P13 in (table 4.9).

De Beer and Nduna (2010), in Ramnarain et.al (2010) stated that science educators should be able to inspire the learners with their science-as-inquiry approach. Competent science educators should strategize and facilitate effective science learning even in the most under-resourced classroom. Improvisation, out-of-box thinking and a pinch of creativity are of paramount importance. Hands-on, minds-on and heart-on learning should be ensured at all times.

De Beer and Nduna (2010), in Ramnarain et.al (2010) further developed a strategy to offer science in a scientific investigative style. The following steps have been suggested:

- Organise other colleagues to equip classrooms with facilities over a period of time.
- Group discussions can be established whereby neighbouring schools may share equipments.

- Secure funds from school fund to purchase equipments from Somerset Educational or Radmaste centre at Wits University.

Lastly, De Beer and Nduna (2010), in Ramnarain et.al (2010) emphasised that shoestring approach or low cost is not the second best solution or inferior but can be beneficial to under resourced schools similar to ours in Limpopo Province of South Africa. Shoestring approaches often deals with the effective domain and bring back the classroom. Educators are encouraged to pass through concrete operational phase and to be engaged in hands on experience.

Onwu, Botha, de Beer and Dlamini, in Van Rooyen and de Beer (2007:204) quoted the following comments from teachers cluster meetings:

> *"How can I be expected to teach science successfully without the necessary apparatus? I do not have material and therefore I am unable to teach science effectively!"*

The above comments are common and similar to the ones made by the majority of the participants in this study who are incompetent and mostly are not good curriculum designers and materials.

The significance of the study, which we can learn stays in its proposition of how schoolroom-based assessment can be satisfactorily planned and applied to calculate complicated scientific knowledge while staying carefully with teaching. As educators, we have learnt that the assessment arouses learning rather than reasonable showing learning (Black & Wiliam, 1998). The technology enhanced learning in science (TELS) approach has the following to offer which we can learn as South African educators.

National Curriculum Statements (NCS) grades R-9 (schools) policy (DoE, 2002:13) define the term ñprocess skillsò as:

> ñ*Learner`s cognitive activity of creating meaning and structure from new information and experiences. The examples of process skills are observing, making measurements, classifying data, making inferences and formulating questions for investigation."*

During interviews, about six (6) participants showed little understanding of process skills whereas seven (7) participants showed no understanding of process skills although the researcher used the word ñstrategiesò instead of process skills.

The researcher asked Participant 9 about the strategies to be followed when conducting Scientific Inquiry. Then Participant 9 responded as follows after it was repeated twice:

> *"(Err) Observation… more than anything, because we do not have …. Enough space for learners to do things for themselves."*

The same participant 9 was asked about the focus question and responded as follows:

> *"The focus question, I think is the main. Main (err) objective of the lesson, of the investigation"*

From the instruction point of view, as the NCS policy (DoE, 2002:13) states, the part of the process skills in the teaching and learning of science can be viewed as the developing blocks from which appropriate science activities are constructed. Within a framework of process skills, educators are encouraged to formulate questions which motivate the kind of thinking desired by the learning outcomes, especially LO 1: Scientific Investigations. On the same breadth, from the learning point of view, process skills are vital and essential means by which the learners involves with the world and advances rational control of it through the construction of concepts.

During assessment as well, a framework of process skills is important when they are planning rating scales, making memos and instruments like rubric to record the day-to-day participation of learners (DoE, 2002:13).

During observations of the designed lessons attached as Annexure D (scanned lessons) as well as observations of the participants in practices (Part 1 and 3) it was clear that almost all participants do not understand how to conduct Scientific Investigations (LO:1). Further evidence to depict lack of knowledge on how to conduct Scientific Investigations (LO: 1) is found from Annexure B (Transcripts of Observation lessons). The participantôs files were analysed to check whether they assess learners according to the policy and if the observation sheet, rubrics and practical score sheets are used during assessment. The findings were that almost all participants do not have an instrument to show that they used to assess learners when conducting Scientific Investigations (LO: 1)

5.5 RECOMMENDATIONS AND IMPLICATIONS

5.5.1 Recommendations and Implications for Educators

Martins in Bosman (2006) identified at least three difficulties in knowing enough science content:

- the amount of science known today is enormous,
- scientific knowledge may become obsolete in future,
- scientific knowledge changes over time.

Research done by Darling-Hammond as revised by Goodrum, Hackling and Rennie in Bosman (2006) pointed out that educatorö perspective of science content, learnerö knowledge and improvement, and instruction style are totally vital components of educator resourcefulness. Meticulous preparation which integrates science subject matter and perspective of the student is therefore crucial. To develop quality pedagogical content knowledge takes time and experience. A good science teacher is therefore not born, but made. This is against the long-standing myths that:

> *"Anyone can teach" and that "teachers are born and not made"* (Bosman, 2006:173).

According to Goodrum, Hackling and Rennie (in Bosman, 2006) educator schooling is utmost vital to the excellence of the between instruction and learning. In Australia, in primary schools, many teachers blamed their lack of firm understanding of scientific principles on poor teacher training. Very few teachers experienced science as a programme.

Newton (in Bosman 2006) emphasised that in the UK (as in most other countries) planning to offer science is an obligatory part of preliminary educator preparation procedures. The procedures are mainly too dumpy to conceal the width of science, and educators are then probable to design and improve their individual subject matter to a noteworthy point.

In most countries, primary teachers (as are Foundation Phase teachers in South Africa) are generalists, teaching all learning areas. Many teachers find their understanding of science challenged by the demands of the curriculum which they are required to teach.

Teachers who lack content knowledge and confidence often attempt to minimise their difficulties through avoidance of topics in science, heavy reliance on texts, and overemphasis on practical activity (Asoko in Bosman, 2006). Educators should also engage in professional development activities in which they improve their qualification.

Tertiary institutions equip educators with necessary skills and knowledge to implement the curriculum. If the education system changes and tertiary institutions change their curricular to move in line with changes, if educators engage themselves in further studies, they will acquaint themselves with the changes that take place.

Gilmore (in Ramoroka 2006) argues that planned professional development opportunities increase educatorsô assessment capacity. Educators who engage in further studies are updated with changes taking place in the education system. Knowledge keeps developing and as such this influence change in curriculum development. As curriculum keeps on changing, qualifications that were achieved in one year may not be useful in ten years to come. It is essential for educators to improve their qualification so that they can be up to date with changes in the curriculum.

The government on other hand has a huge responsibility to seriously train curriculum advisors for at least 6 months and educators as well. Most of the participants have more knowledge of Natural Sciences but they lack skill on how to conduct scientific investigations. If educators are well trained, they can produce the best scientist the country needs in 21st Century.

In her conclusion, Bosman (2006:234) recommended that foundation phase educators should be given a chance to upgrade their information and abilities through continuous professional development and in-service training. Teacher educating organizations should be encouraged to have sufficient preparation in their programmes to prepare foundation phase educators for the complicated activity lie ahead of them.

According to Kriek and Grayson (2009:186)

> *"Professional development of teachers is not new but in recent years the way in which it is structured and delivered is being reconceptualised."*

I concur with Reddy in Kriek and Grayson (2009:186) who explained that there are multiple, complex problems that contribute to learner`s performance in physical science because the same learners did not get good scientific background.

The problems identified by Reddy in Kriek and Grayson (2009:186) are similar to the ones I found during my study which includes amongst others, poverty, resources, learning cultures, infrastructure (laboratories) and low teacher qualification (refer to Table 4.2).

Most importantly, above all this odds, the Holistic Professional Development (HPD) model yielded results. I recommend that the participants who took part in my study should undergo a Holistic Professional Development (HPD) model because it explicitly integrates the development of teachers along the three (3) dimensions as content knowledge, teaching approaches and professional attitudes.

I further recommend that the one-year distance programme be introduced at some South African universities to develop the educators teaching Natural Sciences in the Intermediate Phase whereby university would develop study guides, offer compulsory assignments, teaching content knowledge of Natural Sciences as well as teaching the them good scientific approaches and develop their professional attitudes towards Natural Sciences teaching.

The advantage of distance mode teaching will allow educators to work in their own time, without having to leave their classroom or attend lectures during their holidays. In their conclusion, Kriek and Grayson (2009:200) found that ñimprovement of educatorøs content knowledge increases teacherøs confidence, which makes them more prepared to use a variety of teaching strategies, more learner-centred and activity-based approaches.

5.5.2 Recommendation for Policy and Practice

There should be enough resources and adequate supply of quality learning support materials. According to the Department of Education Educator guide (2002:4)

> *"The implementation of C2005 took place in an environment characterised by enormous infrastructural backlogs, resources limitations, inadequate supply of quality learning support materials and absence of common national standards for learning and assessment".*

Participant (P3) stated lack of laboratory and other resources (see Table 4.9). There are still infrastructural backlogs because some classrooms are overcrowded. In some schools more than 90 learners are congested in one classroom. Many educators still rely on the textbook, chalk and chalkboard as learning support materials only. These resources are really inadequate for the successful implementation of the NCS policy whereby educators are expected to conduct scientific investigations let alone simple experiments and confirmatory.

Smit in Ramoroka 2006) argues that educators should be involved when the education policy is planned. Vambe (2005:285) demonstrates in what way the guiding principle of outcomes-based education (OBE) had been utilized as an approach for instructive change. The piece of writing contends that, while (OBE) could be appreciated background of the wish for transformation, the curriculums accomplishment did not spearhead to far reaching and qualitative conversion of the South African scholastic department. The researcher recommended that any theory of drastic encouragement through diplomatic and purpose promotion programs want to take into account the perspective of the original of organisation of educator training of the qualified excellence of learners, and the quality of the few students.

Ogunniyi (2007:1990) states how difficult it was to implement the NCS due to dissatisfaction and demonstrations by teachers. In conclusion, during the research process of the Practical Argumentation Course, the course looked to have improved the student perspective of, and thankfulness for a science ï IKS (Indigenous Knowledge Systems) curriculum. In my opinion, without sufficient guidance, tracked by a long-lasting supporting curriculum, educators may not be intelligent to execute the policy magnificently.

Prospectus mentors at the circuit levels should frequently organise workshops to empower teachers on the integration and interpretation of the assessment standards. Teachersô recommendations of the PAC- (Practical Argumentation Course) necessitate a follow-up in their schoolrooms and backing their strengths to execute the NCS magnificently.

Stoffels (2005:147) concurs with the major democratic program communication that educators are awaited to be resourceful policy designers and cultivates resources materials, agreeing to the requirements of their students (DoE, 1998).

Rogan (2004:117) indicates a number of influential students citing that this creative drive has not emerged and that very few teachers can and actually do that. Stoffels (2005:147) asked this question: Exactly how do teachers interpret and use the new learning support material? Educators should observe other educators or curriculum advisors interpreting and integrating assessment standards when conducting scientific investigations. Observations are important to help one to have a better understanding of what happens in practical situation.

In the past student, educators could take a week or two conducting observations in schools. After conducting those observations, they would take time for practical teaching. When OBE was phased in, most of the educators were expected to implement OBE without having observed an OBE lesson. If they had been allowed to observe for OBE lessons, they perhaps would have better understanding of OBE and they would implement this approach effectively in their classrooms.

The same applied when the NCS policy was introduced. There were no lessons observed and even workshop facilitators did not have a good understanding of how to interpret and integrate assessment standards when conducting Scientific Investigations in Natural Sciences in the Intermediate Phase. The NCS and CAPS policies are good, but they are not easy to implement. For example, with regard to promotion of learners, the Department of Education requires that learners should not spend more than four years in a phase, which is a idea but difficult to implement in terms of practice.

This is easier said than done because learners should be promoted every year and it is not easy to use time as a flexible resource as learners learn at different paces. Class sizes should be reduced to 25 or less so that they can be manageable and individual attention can be given to all learners. Most educators in South African schools are faced with more than 80 learners. It is not easy for an educator to give individual attention to such a large number of learners.

5.5.3 Recommendations and Implication for Curriculum Advisors

Curriculum advisors should give support to educators. They should monitor progress in schools. Curriculum advisors meet educators when they call them for workshops. When OBE was introduced in South African schools, educators were called for workshops.

Even when OBE was revised to NCS and later to CAPS policy, workshops were organised. After workshops were conducted very little support was given to educators. Educators struggled on their own after attending workshops.

Curriculum advisors should learn more to have a better understanding of the new curriculum be it the NCS or CAPS. While attending workshops on all the above stated policies, it was realised that curriculum advisors have little knowledge regarding all the policies, OBE, NCS and CAPS. This may be because curriculum advisors themselves were sent to their own workshops that lasted about a week or two and they came back to workshop educators.

Some of the curriculum advisors would not allow educators to ask questions. They thought that educators were testing their knowledge whereas educators wanted to have better understanding of how they should implement policy in question.

5.6 LIMITATIONS OF THE STUDY

This investigation was limited to the educatorsô interpretation and integration of the assessment benchmark of Learning Outcome 1: ñScientific Investigationsò (DoE, 2002:6) in the teaching of the Natural Sciences in the Intermediate Phase and the influence it had on the lesson task designed, learning facilitation and assessment practices. It was designed in order to determine whether there has been some development and improvement of educators` understanding of the NCS policy, since the inception of OBE in South African education system. The investigation was limited to Intermediate Phase educators and teaching Natural Sciences and particularly on the LO 1: Scientific Investigations. Due to lack of laboratories at schools, only participants P3, P6 and P8 (in Table 4.26) performed confirmatory experiments in their classrooms. Even after the participants were instructed to teach learners on how to conduct scientific investigations, they prepared (designed) lesson tasks well but could not conduct scientific investigations. The results could have been different if all participants were able to conduct scientific investigations.

5.7 RECOMMENDATION FOR FURTHER RESEARCH

Further research is needed to focus specifically on the Senior Phase and FET phase. In this investigation, it was established that educatorsô understanding of scientific investigations in the Intermediate Phase teaching Natural Sciences is a serious problem based on their opinions during interviews and when their documents were analysed as well as during my observations while they are in practice. Almost all educators in this study have little or no understanding of how to interpret, integrate assessment standards when conducting scientific investigations when teaching Natural Sciences in the Intermediate Phase. Learner understanding of scientific investigations can as well be investigated as an independent research. More research is needed as well to determine the reasons why educators are not conducting scientific investigations in the classroom.

5.8 CONCLUSION

The level of educator understanding of scientific investigations in the Intermediate Phase teaching Natural Sciences is still low. This may be true for the area in which this investigation was conducted because schools are found in different situations. Some schools may have enough resources and knowledgeable educators who can interpret and integrate the assessment standards of Learning Outcome 1: Scientific Investigations well. Almost all participants in this investigation have little or no understanding of how to interpret and integrate the assessment benchmark of Learning Outcome 1:ñScientific Investigationsò (DoE, 2002, 16) teaching Natural Sciences in the elementary Phase.

Most educators do not conduct scientific investigations in their classrooms let alone simple experiments or even confirmatory experiment but they rely on direct instruction. A number of factors may lead educators to rely on direct instruction and not to integrate the assessment benchmark of Learning Outcome 1: ñScientific Investigationsò (DoE, 2002:16) when teaching Natural Sciences in the Intermediate Phase. The factors may be lack of understanding on how to conduct a Scientific Investigation, how to integrate the assessment standards during the process, how to assess the investigation as well as the assessment tools to be used when assessing an inquiry.

Educators still need to undergo intensive training in order to understand how to interpret, integrate assessment standards when teaching Natural Sciences in the Intermediate Phase and for them to implement the policy effectively in the classroom, particularly when conducting scientific investigations.

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