

**CHALLENGES FACING PHYSICAL SCIENCE EDUCATORS IN
THE IMPLEMENTATION OF THE NATIONAL CURRICULUM
STATEMENT: THE CASE OF THE EMPANGENI EDUCATION
DISTRICT**

BY

STEPHAN PARAFFIN MCHUNU

**A dissertation submitted to the
Faculty of education in fulfillment of the requirements for the Degree
of**

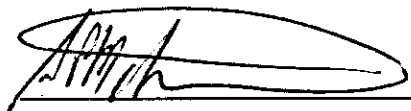
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in the
Department of Mathematics, Science and Technology Education.**

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KWADLANGEZWA**

**Supervisor: Prof. S.N. Imenda
Co-Supervisor: Mr M.S. Ntuli**

Submitted: JUNE 2009

SIGNATURE:

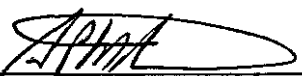
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DECLARATION FORM

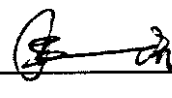
I Stephan Paraffin Mchunu of 2 Milky Way, Carsdale Suburb, Empangeni, sincerely and solemnly declare that the copy of the dissertation submitted by me in June 2009 is original. It is in no way the work of someone else. The product is the result of my efforts through the professional guidance of the recognized supervisors whose names and signatures appear below:

Candidate's Name: S. P. MCHUNU

Candidate's Signature: 

Date: 19/11/2009

SUPERVISOR

NAME: SN IMENDA SIGNATURE:  DATE: 19/11/2009

CO-SUPERVISOR

NAME: M. S. NTULI SIGNATURE:  DATE: 16-11-2009

FACULTY TUTOR ACKNOWLEDGEMENT

NAME: _____

DATE: _____

DEDICATION

This dissertation is dedicated to:

My wife Zodwa Magaret Mchunu, my son Siyethaba Dalitso Mchunu and my daughter Sibusisiwe Nokubonga Mchunu.

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ACRONNYMS AND ABBREVIATION USED IN THIS STUDY

OBE:	Outcomes-Based education
FET:	Further Education and Training
GET:	General Education and Training
IKS:	Indigenous Knowledge System
NCS:	National Curriculum Statement
SMT:	School Management Team
CASS:	Continuous Assessment
NQF:	National Qualification Framework
AS:	Assessment Standard
LO:	Learning Outcome
CO:	Critical Outcome
DO:	Developmental Outcome
SEM:	Superintendent of Education Management
NGO:	Non-Governmental Organization
SAG:	Subject Assessment Guidelines
LPG:	Learning Programme Guidelines
CPTD:	Continuing Professional Teacher Development
OBA:	Outcomes-Based Assessment
PCK:	Pedagogical Content Knowledge
POE:	Predict Observe and Explain

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CHAPTER ONE

INTRODUCTION

1.1 OVERVIEW

This chapter presents the background, the statement of the problem and the purpose of the study. It also presents research questions, a brief statement of the methodology, definition of terms and the structure of the dissertation.

1.2 BACKGROUND

This study looked at the implementation of the NCS physical science as a major curriculum change. As Imenda (2002:4) states "curriculum change entails that educators, learners, administrators, and all those with a part to play in the actualisation of the new curriculum have to see and do things differently". He further asserts that "this invariably means embracing a new system of doing things in terms of a sound philosophical basis, curriculum content description, beliefs, values, convictions and practices". He further posits that "the transition from an 'old' curriculum to a new one could therefore present difficult challenges and problems". According to Imenda (2002:4), "the espousal of OBE by South Africa's Ministry of Education to apply to all levels of the education system has presented a number of major challenges". Indeed, there are many challenges facing physical science educators in the implementation of OBE, including overcrowding, language mismatching, teacher unpreparedness, non-delivery of OBE resources, inadequate facilities and resources (Adler & Reed, 2002:60-65; Jacobs, Gawe & Vakalisa, 2002:106-107 & De Waal, 2004:63-66).

In particular, student assessment is an integral part of the outcome-based approach to curriculum design and implementation. Accordingly, the implementation of valid and reliable assessment procedures is a centre piece

of outcomes-based education (OBE). The paradigm shift from the traditional curriculum to an OBE curriculum requires changes to be reflected in assessment practices. Thus, unless assessment is properly aligned with the curriculum reform and teaching, the desired changes in education will be extremely difficult, if not impossible, to realise.

The current reform initiative in science education emphasizes the importance of teaching learners to be critical thinkers and problem solvers. Assessing whether learners understand basic science concepts and can use them to solve problems requires an approach very different from traditional tests that primarily measure the recall of isolated facts. As Rasool (1999: 177) points out:

The traditional educational paradigm prevalent in schools is characterized by a heavily content-driven, teacher centered approach. Subjects are broken down in terms of rigidly defined syllabuses and tend to be knowledge focused rather than performance focused. While methodologies vary, the role of the teacher as a subject matter expert is largely that of provider of content.

The following points are noted from the traditional curriculum:

- Learners are often passive recipients of knowledge.
- Emphasis is on memory, practice and rote learning.
- Promotion of learners is based mainly on pencil and paper examinations.
- Little or no emphasis is on creativity and the curriculum is overloaded with content; no attention is given to skill.
- No emphasis on co-operative learning and discovery learning.
- Competencies, knowledge and skills are not improved.

- Skills acquired outside school are regarded as inferior and largely not recognized (Department of Education, 1997: 27).

In the new curriculum, the full scientific power of pupils is assessed. Students' performance is compared with established criteria; students are viewed as active participants in the assessment process; assessment is regarded as continual and recursive. Overall, outcome-based assessment focuses on work done, assesses understanding and is motivational in nature (Lorraine, 1998: 58).

1.3 THE STATEMENT OF THE PROBLEM

The National Curriculum Statement Grades 10-12 puts more emphasis on high level knowledge and skills (Kelder, 2005:4). It sets out high expectations of what all South African learners can achieve by specifying the minimum standards of each grade and sets high, but achievable, standards in all subjects.

The new Further Education and Training (FET) curriculum makes two core demands on physical science educators:

- To organise a learning programme that enables learners to develop all skills, knowledge, values and attitudes relevant to physical science.
- To have a sound, up-to-date knowledge of the content and methods of the subject and a clear understanding of its social relevance, so that an educator can act as a guide, facilitator and a subject expert in the classroom (Kelder, 2005: 4).

These two core demands pose a problem or challenge to physical science educators in the following ways:

- They need thorough training on the new curriculum in order to adequately deal with these core demands. The reason for this is that

the majority of physical science educators obtained their secondary education in schools which did not have well-equipped science laboratories and they were taught in a traditional way. Most of these educators were subsequently trained in colleges of education similarly ill-equipped. In this regard, educator training has largely been insufficient, resulting in educators lacking in exposure to science apparatus and/ or laboratory equipment. Hence, the skills necessary to be transferred to learners are lacking.

- Educators will battle to plan the lessons with the activities to help learners achieve their learning outcomes, particularly Learning Outcomes One and Three (LO 1 and LO 3). Learning outcome One concerns learners' ability to use process skills, critical thinking, scientific reasoning and strategies to investigate and solve problems in a variety of scientific and technological, environmental and every day contexts (Department of Education, 2005: 7). Learning Outcome Three is about the learners' ability to identify and critically evaluate scientific knowledge claims and the impact of this knowledge on the quality of socio-economic, environmental and human development (Department of Education, 2005:7). In this regard, it would be quite possible that poorly prepared educators would find it difficult to use content in order to ask questions that relate to outcomes. Furthermore, they may find it hard to shift from content-based assessment to outcomes-based assessment. In addition, designing rubrics for assessment is also a skill to be developed by science educators. Another challenge is the use of effective and efficient assessment practices, particularly in overcrowded classes. Added to this is the important issue related to appropriate facilities, that is, some schools do not have science laboratories and science equipment.

The implication of the changes to the curriculum is that educators need to have an adequate understanding of all these changes and skills to carry out their various tasks successfully; otherwise they themselves could become barriers to the introduction, management, and the implementation of the National Curriculum Statement (NCS). Educator empowerment may be seen as the main strategy for providing educators with facilitating skills.

In 1975, Stenhouse argued that the reasons curriculum developers were not getting through to the average teacher was not because of resistance to change but because of barriers to change. He identified these as:

- Lack of clarity about new ideas;
- Teachers lacking skills and knowledge required to implement change;
- Lack of resources and equipment; and incompatible organizational arrangements (for example, rigid timetabling) (Jones, Clark, Figg & Howard, 1989:198).

Another crucial issue is one related to parental support. Although parental support has always been an important enabling factor for school success, the current curriculum which defines the child's entire environment (home included) as a learning platform, places parents and guardians as equally important as school teachers for the school success of their children. Indeed, the education situation in the home and the teaching situation in the school are both essentially social situations. According to Bastiani (1987:198) education of their children is paramount to responsible parenting. Parents

want to be kept informed of their children's progress in school and to be involved in their children's education. Parents also need and are interested in other kinds of information, education and involvement (Pillay, 1995:36). Overall, parental involvement in school activities is based on the natural rights of parents to educate their children (Badenhorst, Botha, Lion-Cachet & Van der Linde, 1994: 15). According to Dekker and Lemmer (1993:154), Lemmer and Squelch, (1993:60), parental involvement in schools is significantly related to:

- Improved student academic achievement;
- Improved student attendance at school;
- Improved student behaviour; and
- Increased community support for schools, including human financial and material resources.

Macbeth (1989:32) maintains that "the education of the individual child is presumably the most important reason for parent-teacher cooperation". Oosthuizen (1992:125) asserts that "parents should become more actively involved in the teaching of programmes in the school".

This study focuses on the totality of the implementation of the NCS of physical science. In particular the study looks at parental support, opportunities for

staff professional development, facilities and resources and student assessment as possible challenges facing physical science educators in the implementation of OBE in the Empangeni Education district.

1.4 THE AIM OF THE STUDY

The aim of this study was to assess the implementation of the NCS by physical science educators, in the various aspects of the requirements of the curriculum. In particular, the study sought to address the research objectives listed below.

1.5 RESEARCH OBJECTIVES

Pursuant to the above aim, this study set out to address the following research objectives:

1.5.1 To determine the role played by parents in supporting their children in the implementation of the new curriculum;

1.5.2 To find out the instructional strategies used by physical science educators, particularly where the necessary laboratory facilities and other attendant resources are absent or in short supply;

1.5.3 To find out the assessment strategies, processes and procedures commonly used by science educators in the implementation of the NCS; and

1.5.4 To determine the professional development needs of physical science educators.

1.6 RESEARCH QUESTIONS

The principal objective of this study was to find answers to the following critical questions:

- 1.6.1 What role do parents play as a way of supporting their children in the implementation of the NCS new curriculum?
- 1.6.2 What instructional strategies do physical science educators use in their adaptation to the new curriculum, particularly in lieu of the necessary laboratory facilities and other resources?
- 1.6.3 What assessment strategies, processes and procedures do physical science educators commonly use in the implementation of NCS?
- 1.6.4 What are the professional development needs of physical science educators for the effective implementation of the NCS?

1.7 METHOD OF STUDY

The research methods followed in this study are briefly outlined below under a couple of sub-headings.

1.7.1 Research Design

Schumacher and McMillan (1993: 31) refer to research design as the plan and structure of the investigation used to obtain evidence to answer research questions. In this regard, research design may be seen as the consideration and creation of means of obtaining reliable, honest, transferable and valid data, by means of which pronouncements about the phenomenon may be confirmed or rejected. In concurrence, Mc Kendrick (1987:256) posits that research design is an overall plan or strategy by which questions are answered where a hypothesis is tested.

This study was largely located within the qualitative research paradigm, and took the form of a case study involving seven (7) selected schools

from Empangeni District. The researcher identified individual science educators from different schools in the Empangeni District. The educators selected were deemed information-rich in terms of data that were to be collected. The researcher was interested in obtaining detailed information related to instructional and assessment strategies as understood by the physical science educators.

Case studies constitute an important and useful means for gathering data in qualitative research. According to Cohen and Manion, (1990) a case study is a technique the researcher uses to observe the characteristic of an individual unit, for example a school, child, or community. Best and Kahn, (1989) define the case study as a way of organising social data for the purpose of viewing the social reality. Yin (1983:22) defines a case study as an enquiry that investigates a contemporary phenomenon in which multiple sources are used. Thus, this study used the case study research design to examine the instructional and assessment practices of physical science educators in the Empangeni district in the KwaZulu Natal Province.

1.7.2 Research Techniques

Questionnaires

Questionnaires were used as a technique to collect data from the selected science educators. The questionnaires were prepared and administered to science educators and learners from schools chosen using stratified random sampling. There were two categories of schools that were chosen for this study, that is, schools from rural and urban area schools. There were three ex-Model C schools among the schools that were chosen from the urban

area. The main purpose of this was to ensure that both categories of schools were covered in the research.

Observation Schedule

An observation schedule was prepared. Seven (7) schools which were chosen through random sampling were used as the sample for the study.

1.8 DEMARCATION OF THE FIELD OF STUDY

This study focused on selected educators' instructional strategies and assessment practices in physical science. Seven (7) secondary schools in the Empangeni District were selected as the research sample for the study. Empangeni District is one of the districts in the KwaZulu-Natal Province. Two circuits of schools were chosen from Empangeni District, that is, the Lower Umfolozi Circuit and the Mthunzin Circuit. Schools selected were located in Ngwelezane, Richards Bay and KwaMbonambi wards. Three (3) high schools in Richards Bay, three (3) high schools from Ngwelezane ward and one (1) high school from KwaMbonambi wards were selected for the study. Altogether, there are 73 high schools in the Empangeni District.

1.9 DEFINITION OF TERMS

The terms frequently used in this study are briefly defined below.

1.9.1 Effectiveness

Effectiveness refers to doing the right job right, achieving maximum results with minimum use of resources. It is the capability of producing the results that are intended or wanted. According to the South African Concise Oxford Dictionary, effectiveness refers to the act of producing a desired or intended result. The desired or intended results according to this study related to enabling all learners to reach their maximum learning potential in terms of the

Learning Outcomes set to be achieved by the end of the education process. Outcomes-Based Education (OBE) encourages a learner-centred and activity-based approach to education. The National Curriculum Statement (NCS) builds its Learning Outcomes for grades 10 – 12 on the Critical and Developmental Outcomes (Department of Education, 2003: 2). Effectiveness implies that daily assessment activities are designed to provide learners with opportunities to develop and sharpen their:

- Practical, scientific and problem-solving skills;
- Ability to construct and apply scientific knowledge; and
- Ability to identify and critically evaluate the contested nature of science and its relationships to technology, society and the environment (Department of Education, 2007: 7).

1.9.2. Assessment

Assessment in OBE is described as a process of gathering valid and reliable information (evidence) about the performance of the learner, on an on-going basis (CASS), against clearly defined criteria, using a variety of methods, tools, and techniques in different contexts (Department of Education, 2005: 6). Assessment is a critical element of the NCS Grades 10-12. It is the process of collecting and interpreting evidence in order to determine learners' progress in learning and to make judgments about learners' performance. Evidence can be collected at different times and places, and with the use of various methods, instruments, modes and media. Assessment is the means we use to gather information about how much learners have learnt. In OBE, assessment is part of learning and not a separate activity. Assessment helps learners to gauge the value of their learning (Department of Education, 2003: 55). In this regard, Assessment should:

- Be understood by the learner and by the broader public;
- Be clearly focused;
- Be integrated with teaching and learning;
- Be based on the pre-set criteria of Assessment Standards;
- Allow for expanded opportunities for learners;
- Be learner-paced and fair;
- Be flexible;
- Use a variety of instruments; and
- Use a variety of methods (Department of Education, 2003: 57).

1.9.3 Efficiency

Efficiency refers to doing the job right, achieving the results with the use of resources whereas effectiveness refers to doing the right job right, achieving maximum results with minimum use of resources (refer to definition 1.9.1). It is the quality of being able to do a task successfully, without wasting time. It is also the quality of doing something well and producing the results that are intended without wasting energy (Collins, Cobuild Learners' Dictionary). With reference to assessment, efficiency means assessing learners correctly and skilfully.

1.9.4 Outcomes

Outcomes are final results that should be achieved by learners by the completion of the learning process. This achievement needs to be supported by measurable evidence. The outcomes and standards to be achieved should be fully described at the beginning of the process so that the final results to be achieved are clear (Department of Education; 2002-2005:4).

1.9.5 Outcomes-Based Education

Outcomes-Based Education (OBE) is an approach, which describes the skills, knowledge, understanding and values that are the result of learning. OBE replaces the existing content-based approach, which defines what learners do during the learning process. OBE allows educators to recognize achievement without an exaggerated regard to how the learning happens (Department of Education, 2002-2005: 3)

OBE enables learners to progress at their own pace, providing them with numerous opportunities to achieve the required Assessment Standards (AS) and Learning Outcomes (LOs). Assessment Standards are statements that specify the depth and breadth of what a learner should be able to do.

1.9.6 Practices

Practices refer to things that people do regularly, or it is a regular activity that is done in order to improve a skill. With reference to this study, practices refer to educators assessing learners, learners assessing each other (peer assessment) and learners assessing themselves (self assessment) continuously and daily using current methods, tools and techniques of assessment. As a good practice, educators should develop a year-long formal programme of assessment for each subject and grade (Department of Education, 2005: 2).

1.9.7 Empowerment

The concept of empowerment is widely used as a buzz-word for sharing expertise, initiative, problem-solving and decision-making (Pillsbury, 1989; Phillip, 1993). According to the South African Concise Oxford Dictionary, empowerment refers to giving authority, power, strength or confidence to someone. This concept entails pooling together of resources to bring about change and to improve conditions by way of motivating and enabling the agents of change and empowerment.

Rappaport (1987: 122) describes empowering as 'a joining of personal competencies and abilities to environments that provide opportunities for choice and autonomy in demonstrating those competencies'.

Empowerment means bringing together resources and decisions as close as possible to where the action is. With regard to empowerment, the concept in this study means getting involved, taking initiatives towards self-empowerment, understanding educational change, thus becoming an effective change agent and helping others towards implementing change. Teacher empowerment is described in educational literature as a multi-dimensional contract that is often used to define 'new roles' for teachers (Fullan, 1993; Griffin & Moorhead, 1995). Teacher empowerment further involves understanding educational laws and regulations in relation to the Constitution of the land (cf. Act No. 108 of 1996) and thus implementing them accordingly. It further means fair practice of democracy in the institution and upholding the human rights, culture and freedom enshrined in the national Constitution (Act No. 108 of 1996).

Empowerment is the process by which people, organizations and communities gain mastery over issues of concern to them. Empowerment is a contract that links individual strengths and competencies, naturally helping systems, and proactive behaviours to social policy and social change (Rappaport, 1984).

Empowerment also means enabling teachers as individuals and as groups to rid themselves of anxiety, despair, low self-esteem, uncertainty and lack of confidence. Empowerment in this study is seen as a strategy to enable physical science educators to facilitate educational change.

1.9.8 Staff Development

The terms 'staff development', 'professional development' and 'in-service education' tend to be used interchangeably for the process of individual development and that of organizational growth (Dean, 1991:4,5). For example Williams (1982) suggests that staff development is the process by which individuals, groups and organizations learn to be more effective and efficient. Cawood and Gibbon (1981) describe staff development as an experiential involvement by a teacher in the process of growing. This process is not short term. It is a continuous, never ending developmental activity. According to Burke, Heideman and Heideman (1990 :4)), "staff development is concerned with personal as well as professional and organizational needs".

1.9.9 In-Service Education and Training

Morant (1981) says in-service education and training is the education intended to support and assist the professional development that teachers ought to experience through their working lives. According to Burke, Heideman and Heideman (1990), "in-service education is not synonymous

with staff development". They further state that "in-service education is only one part of staff development, being almost exclusively informal in nature". In contrast, "staff development goes beyond the informational stage; it involves adaptations to change with the purpose of improving student achievement".

1.9.10 Professional Development

Dean (1991:5) states that "the term 'professional development' suggests a process whereby teachers become more professional". The term 'professional development' implies a number of things. Dean further states that "the most commonly accepted definitions of a profession are of an occupation which requires a long training, involves theory as a background to practice, has its own code of behaviour and has a high degree of autonomy "(Dean, 1991:5). Professional development is career long, starting with initial training and continuing until retirement (ibid).

1.10 THE STRUCTURE OF THE DISSERTATION

CHAPTER ONE

Introduction

This chapter provides the context and background to the study, the statement of the problem, purpose of the study, research questions and a brief overview of the methodology. It also presents the delimitation of the field of study, definition of terms and the structure of the dissertation.

CHAPTER TWO

Review of Literature and the Conceptual Framework

This chapter discusses literature review for the study regarding the changes in curriculum expected to manifest themselves in the classroom practices as

stated by the National Curriculum Statement (NCS) for Physical Sciences. Chapter two mainly discusses the challenges facing physical science educators in the implementation of the NCS and also reflects on possible alternatives physical science educators could use in lieu of laboratory facilities. Furthermore, this chapter discusses the assessment strategies most commonly used by physical science educators.

CHAPTER THREE

Research Methodology

This chapter deals with the research design, procedures and techniques including the method of investigation and the selection of the research sample. This chapter also discusses how data were gathered and analyzed.

CHAPTER FOUR

Results and Discussion

This chapter presents the study's findings as well as the interpretation of the findings and discussion thereof.

CHAPTER FIVE

Summary, Conclusions and Recommendations

This chapter provides a summary of the whole study, conclusions drawn from the findings and outlines the recommendations in relation to the purpose of the study.

1.11 CONCLUSION

In the first chapter the problem of investigation has been delineated and located. The key concepts have been defined and discussed briefly. The method for conducting this investigation was identified and briefly explained. The next chapter deals with the conceptual framework and review of the relevant literature.

CHAPTER TWO

REVIEW OF LITERATURE AND CONCEPTUAL FRAMEWORK

2.1 INTRODUCTION

This study is focused on the implementation of the NCS within the FET band, with particular reference to physical science. The scope of the problem under investigation has been outlined in the preceding chapter. This chapter develops and presents the conceptual framework derived from the review of literature, in line with the research questions of this study. The literature reviewed in this chapter revolves around the themes of the study, that is, (a) parental support and involvement in the education of their children, (b) instructional strategies used by physical science educators, seen against the available facilities and resources, (c) assessment strategies, processes and procedures commonly used by physical science educators in the implementation of the NCS, and (d) professional development needs of physical science educators. In this study 'physical science' is used interchangeably with 'science'.

Butler (1998:32) asserts that with the new curriculum "educators are challenged to be more professional; to work together and learn from each other...". Butler (1998:39) continues to say that "educators do not always assess learners correctly. Sometimes educators do not have all the information necessary to make a valid assessment. At other times educators just make poor judgments". Assessment in physical sciences is therefore, greatly influenced by the human resource in the sense that adequately trained physical science educators are needed to teach the subject, in order to teach and assess it both adequately and appropriately.

2.2 THEORETICAL FRAMEWORK

The theoretical framework discussed in this study includes *inter alia*; outcomes-based education, assumptions serving as rationale for the actual implementation of NCS, instructional approaches used in outcomes-based education, outcomes and the types of outcomes.

2.2.1 Outcomes-Based Education

The NCS curriculum is outcomes-based and it is driven by the Learning Outcomes (LOs) and the Assessment Standards (ASs). Physical science has three (3) learning outcomes to be achieved after the completion of the Further Education and Training (FET) band, that is, after grade 12. Therefore, it is not possible to systematically study the NCS for physical science without locating it within the principles of OBE. The education system in South Africa has experienced a total transformation since the publication of the Policy Framework for Education and Training in January 1994 (ANC, 1994). In this document, among other things, goals were formulated for the education and training sectors. These goals reveal the general political thinking pattern within which the choice of outcomes-based education (OBE) was made (Bamps, Cronje, Elen & Thoka, 1998:14). Further, the Constitution of the Republic of South Africa (Act 108 of 1996) provided a basis for curriculum transformation and development in the country. As the NCS Grades 10 – 12 (General) (2003:2), points out:

Outcomes-based Education (OBE) forms the foundation for the curriculum in South Africa. It strives to enable all learners to reach their maximum learning potential by setting the learning outcomes to be achieved by the end of the education process. The National Curriculum Statement (NCS) builds its learning outcomes for grades 10-12 on the Critical Outcomes (CO's) and Developmental Outcomes (DO's) that were inspired by the Constitution and developed through democracy. (Department of Education, 2003:2):

Thus the general goals of education in South Africa may be summarised as follows:

- To promote access of all individuals to lifelong education and training, irrespective of race, class, gender, creed or age.
- To promote reconciliation liberty, equality and justice, so that citizens' freedom of choice is exercised within a social and national context of equality of opportunity and the redress of imbalances.
- To pursue national reconstruction and development, transforming the institutions of society in the interest of all, and enabling the social, cultural, economic and political empowerment of all citizens.

According to Sieborger and Macintosh (2004:33), "outcomes-based education is an approach to teaching, training and learning which stresses the need to be clear about what learners are expected to achieve". They further state that "outcomes-based education is a learner-centred, result-oriented

approach based on the belief that all learners can learn and succeed” (Sieborger & Macintoch, 2004:33).

William Spady (1994:8), who is seen as the father of OBE, highlights the viewpoint that what and whether learners learn effectively is more important than when and how they learn something. In OBE, “it is important to ensure that all learners will gain the necessary knowledge, skills and attitudes or to be successful lifelong learners, who will fulfill meaningful roles in real life, in and out of school” (Maree & Fraser, 2004:4). With regard to OBE, Spady (1994:9), formulated three assumptions:

- All learners can learn and succeed, but not on the same day in the same way.
- Successful learning promotes even more successful learning.
- Schools control the conditions that directly affect successful school learning.

The three assumptions serve as the rationale for the actual implementation of OBE, guided by its four principles (Spady, 1994:11-20; Spady & Marshall 1991:67). According to Spady, there is no one model for OBE, but OBE's purposes will be achieved if educators apply the following four principles consistently, systematically, creatively and simultaneously:

- Clarity of focus on culminating exit outcomes of significance.

- Expanded opportunity and support for learning success.
- High expectations for all to succeed.
- Design down from one's ultimate, culminating outcomes.

Clarity of focus: According to this principle, the whole curriculum is geared towards what the learners must be able to demonstrate at the 'real' end – that is, at the end of their schooling or university education – before they go on to fulfill their real-life roles in the world. More specifically, this principle gives a clear picture to the educator of the type of learning the learner must demonstrate in executing a performance. The overall focus on critical outcomes in South Africa gives the OBE system a very clear purpose and direction (Maree & Fraser, 2004:5).

Expanded opportunity: Educators must provide more than one opportunity to learners, if they are not successful, to demonstrate important learning. Rigid time frames and schedules must not restrict learning, although there must be limits to every expanded learning opportunity. The application of this principle also implies that educators must change their teaching methods to ensure successful learning for all. Expanded opportunity further implies that the same standards apply to all learners and that there will be no restriction on the number of successful learners. Furthermore, all learners must have the opportunity to be exposed to a meaningful curriculum, quality learning experiences and multiple resources (Maree & Fraser, 2004:5).

High expectations: Learners must be exposed to challenges on a higher level that will raise the standard of expected levels of performance for successful learning. Higher expectations require that no restrictions be placed on the number of learners that can be successful. Normative referenced assessment, where a learner is compared with the performance of a group, must be replaced by criterion referenced assessment, where every learner performs against pre-set criteria (Maree & Fraser, 2004:5).

Design down: In designing and planning a curriculum at a micro level, that is, a learning experience and/or a learning programme, the educator must start with the culminating outcomes and then design back towards the enabling outcomes and the discrete outcomes. In other word, the designing-down process starts with what learners should be able to do at the end of their official learning experience and ends with what must be learnt today (Maree & Fraser, 2004:6).

In the South African context, the designing-down process must start with the critical outcomes, which are broad, generic and cross-curricular, and refer to real-life roles. The next step will be to design down towards the key building blocks on which the critical outcomes depend, namely, the specific/learning outcomes and the lesson outcomes. The last step in the designing down process is to determine which developmental (discrete) outcomes will

enhance and support the performance of the critical outcomes, and to include them in the development of the learning experiences and/or programmes (Maree & Fraser, 2004:6). According to Spady (1994:53):

Specific content and skills are important in OBE because the golden rules of design down require that educators build into their curricula both the knowledge and competence bases that are critical for learners to develop and ultimately apply (omit unimportant knowledge and skills).

The main pedagogical attributes of OBE according to Imenda (2002:13) are:

- To promote active learning (physically and mentally);
- Learners to be assessed on an on-going basis;
- To promote the development of critical thinking, reasoning, reflection and action;
- To promote integration of knowledge (of education and training);
- Learning to be made relevant and connected to real life situations;
- Learning to be learner-centred, teacher to function as facilitator (use of group work, team work and other active learning approaches emphasized);
- Learning programmes to serve as guides that allow teachers to be innovative and creative in planning lessons and other learning activities;

- Learners to be afforded an opportunity to take responsibility for their learning, and should be motivated by constant feedback and affirmation of their worth;
- Emphasis to be placed on outcomes in terms of what the learner becomes and understands;
- Curriculum implementation should allow for flexible time frames which provide for learners to work at their own pace; and curriculum implementation should allow for inputs from the wider community.

2.2.2 Instructional Approaches in Outcomes-Based Education

According to Maree and Fraser (2004:10), “there are different views worldwide regarding outcomes based education”. They further state that, “OBE practitioners position themselves on a continuum between a behaviourist and a constructivist point of view”. According to Spady and Marshall (1991:8-71), “theory describes three outcomes-based approaches in practice, the traditional approach, the transitional approach and the transformational approach”.

The Traditional Approach: According to Maree and Fraser (2004:12):

In this approach, certain aspects of the curriculum are selected by the educator to form the basis of a new curriculum. The outcomes formulated are synonymous with traditional and content-dominated sections, but do not relate to real-world demands and real-life experiences. The context in which learning takes place is bound to the

classroom and the school. This approach is rarely driven by a framework of exit outcomes, but is rather a strive towards an academically competent learner. This approach tends more towards the behaviourist side on the continuum, and the outcomes in this approach are referred to as traditional outcomes.

The Transitional Approach: According to Maree and Fraser (2004:12):

In this approach, outcomes of significance are defined to address higher-order competencies that are essential in all life and learning settings. The focus in this approach is on what is essential for learners to know, be able to do and be like in order to be successful in life after school. The outcomes in this approach focus on higher-order competencies such as critical thinking, good communication, technological application and problem solving.

The Transformational Approach: According to Maree and Fraser (2004:12):

In the transformational approach, none of the existing curriculum and/or schooling is taken as a given and nothing is untouchable. The outcomes in this approach are constructed in terms of real-life roles that competent citizens must fulfill in real life.

Spady and Marshall (1991:70) state it as follows:

When viewed from this future-oriented, life-role perspective, success in school is of limited benefit unless learners are equipped to transfer that

success to life in a complex, challenging, high-tech future. Our prevailing, century-old, Industrial Age curriculum structure and delivery model lack credibility and capacity to generate these kinds of results.

The policy makers in South Africa decided on the transformational outcomes-based approach for South Africa (National Department of Education, 1997:31).

2.2.3 Outcomes

In the South African context, the word outcomes is broadly used as an inclusive term. According to Maree and Fraser (2004:14), the word “refers to everything that has been learnt, including social and personal skills, learning how to learn concepts, knowledge, understanding, methodologies, values and attitudes”.

Spady (1994:49) describes outcomes as:

...the learning results we desire from learners that lead to culminating demonstrations. These results and demonstrations occur at or after the end of significant learning experiences; hence the term ‘culminating’. This means an outcome is not a collection or average of previous learning experiences, but a manifestation of what learners can do once they have had and completed all of those experiences. Outcomes are not simply the things learners believe, feel, remember,

know, or understand, but instead, outcomes are what learners actually can do with what they know and understand.

However, the National Department of Education (1997:25), outcomes are seen simply as "the end products of a learning process."

According to Maree and Fraser (2004:14), outcomes should be meaningful to learners in the sense that:

- Learners will remember and apply them long after a particular curriculum episode has ended.
- They will truly be important in fulfilling learners' future life roles as citizens of their country and the world.

2.2.4 Types of Outcomes

According to Spady (1994:18), "outcomes are categorized into three main groups namely culminating outcomes, enabling outcomes and discrete outcomes".

- **Culminating outcomes:** The meaning of the word 'culminate' is to reach the highest point. Culminating outcomes define what all learners must be able to do at the end of an official learning experience. All learners are exposed to new learning experiences as they proceed through life and will be challenged with a next highest point at a next level. So within the context of outcomes, there is no fixed highest point and the expression of

achieving an outcome must be seen within this context. Culminating outcomes are synonymous with exit outcomes, and can be defined for a whole education system, a qualification or a learning programme (Spady, 1994:18)

- Enabling outcomes: Enabling outcomes are the key building block on which culminating outcomes depend. Enabling outcomes contribute in an interdependent and integrated manner towards learners' ultimate performance success, and are not separate building blocks that are stacked on one another until a culminating outcome is reached (Spady, 1994:18).
- Discrete outcomes: Discrete outcomes are curriculum details that are 'nice to know' but not essential to a learner's culminating outcomes (Spady, 1994:18).

The National Department of Education defines two groups of outcomes, namely critical (essential) outcomes and specific outcomes. These outcomes are prescribed by the Department of Education at national level and encourage a learner-centred and activity-based approach to education (Maree & Fraser, 2004:14).

2.2.4.1 Critical Outcomes

All education and training programmes in South Africa must adhere to the following critical outcomes, which underpin the Constitution and which were

adopted by South African Qualification Authority (SAQA) (Maree & Fraser, 2004:15).

According to (Department of Education, 2003:2), the Critical Outcomes require learners to be able to:

- Identify and solve problems and make decisions using critical and creative thinking (problem-solving skills);
- Work effectively with others as members of a team, group, organisation and community (teamship);
- Organise and manage themselves and their activities responsibly and effectively (self-responsibility Skills);
- Collect, analyse, organise and critically evaluate information (research Skills);
- Communicate effectively, using visual, symbolic and/or language skills in various modes (communication skills);
- Use science and technology effectively and critically showing responsibility towards the environment and the health of others (technological and environmental literacy); and
- Demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation (developing micro-vision).

- The above-mentioned outcomes culminate in knowledge, skills, attitudes and values. For this reason, Maree and Fraser see South Africa's critical outcomes as synonymous with Spady's culminating outcomes: Critical outcomes: Critical outcomes can be seen as synonymous with culminating outcomes. Critical outcomes also refer to real-life roles, as is the case with culminating outcomes. Critical outcomes are broad, generic and cross-curricular; are linked to all fields of teaching and learning; and are of key importance as a focus for both standard setting and curriculum development (Maree & Fraser, 2004:15).

2.2.4.2 Specific Outcomes

Specific outcomes can be seen as synonymous with enabling outcomes. These specific outcomes are derived from the critical outcomes and are constructed in an interdependent and integrated way as building block to enable learners to achieve overall competence in a field, within context, at a given level and are thus the key to progress in learning. Specific outcomes were formulated within context for each learning area of the General Education and Training (GET) phase. These outcomes set up a framework for the knowledge, skills, attitudes and values that learners need to know, understand and be able to demonstrate at the end of a learning experience (National Department of Education, 1997:26).

2.2.4.3 Developmental Outcomes

SAQA has also proposed five additional developmental outcomes that contribute to the full personal development of each learner, as well as social and economic development at large. These developmental outcomes can be seen as discrete outcomes and are thus 'nice to know'.

According to (Department of Education, 2003:2), the Developmental Outcomes (DOs) require learners to be able to:

- Reflect and explore a variety of strategies to learn more effectively (learning skills);
- Participate as responsible citizens in the life of local, national and global Communities (citizenship);
- Be culturally and aesthetically sensitive across a range of social contexts (cultural and aesthetic understanding);
- Explore education and career opportunities (employment seeking skills); and
- Develop entrepreneurial opportunities (entrepreneurship).

2.2.4.4 Learning Outcomes

In the Revised National Curriculum Statement (RNCS) for both the General Education and Training (GET) band and Further Education and Training (FET) band, specific outcomes have been replaced by learning outcomes. Learning outcomes are also derived from critical outcomes and

developmental outcomes. Learning outcomes are a description of what (knowledge, skills, attitudes and values) learners should know, demonstrate and be able to do at the end of a specific phase and can also be seen as enabling outcomes. Learning outcomes do not prescribe content or method, and have also been formulated at national level (National Department of Education, 2002:5).

2.2.4.5 Lesson Outcomes

Lesson outcomes are constructed by educators and denote a description of what learners should know, demonstrate and be able to do at the end of a specific learning experience (lesson). Lesson outcomes can also be seen as enabling outcomes (Maree & Fraser, 2004:16).

Outcomes can be classified in categories according to:

- Operational functions (e.g. culminating outcomes, enabling outcomes, discrete outcomes);
- Curriculum scope (e.g. lesson outcomes, programme outcomes);
- Competency complexity (e.g. traditional outcomes, transformational outcomes);
- Content (e.g. lesson outcomes); and
- Time reference (e.g. qualification outcomes at universities) Spady, 1994:59).

2.3 PARENTAL INVOLVEMENT

As stated in chapter one, parental involvement is an important factor in the school achievement of learners. Muijs and Reynolds (2001:103) assert that “one of the main things that parents can do to help their children complete their homework is to provide a quiet and private space where the child can do his/her homework”. They further point out that “this does not necessarily mean that parents should make sure that children turn the radio off or don’t listen to music” (Muijs & Reynolds, 2001: 103). To the contrary, according to Hallan and Cowan (1999), listening to music can aid concentration. Probably this will differ from child to child and children should be allowed to listen to music while studying or completing homework if they feel comfortable doing so (Muijs & Reynolds, 2001:103).

Parents should encourage their children to complete their homework and should support their children when they ask for help without actually doing the homework for them (Hallam, 2004). Showing an interest in homework will help give children the feeling that homework is important and valued (Muijs & Reynolds, 2001: 103). Muijs and Reynolds (2001:103) further suggest that “parents can also help by establishing a routine in which a certain time of the day is set aside for homework completion”. If possible, parents can help pupils develop their time management and organisational skills (Muijs & Reynolds, 2001:103).

On its part, the school can help parents by giving them the information they need and regularly communicate with them on homework related issues. If there is a school-wide homework policy, parents should be made aware of this (Muijs & Reynolds, 2001:104). One method that can help involve parents in their children's school work is to give homework in the form of games that can be played with parents and siblings, while reinforcing principles that need to be learnt (Bryan & Sullivan, 1995). The most active research concerns developing and implementing programmes that encourage parents to help with homework at home (Campbell & Verna, 2007:503). In this regard, it is assumed that parental help with homework will lead to higher achievement. In supporting their children, Campbell and Verna (2007:511) suggest that parents should also utilize varying amounts of pressure when children do not work hard enough. They further maintain that effective families do not use fear to motivate their children. Pressure and support can play a role in building academic self-concepts (Campbell & Verna, 2007:512).

The role of parental involvement in education has received greater interest over the years. One other point is the one related to home-school relationships. Home-school relationships, undoubtedly, have an impact on learning of children at school. A learner whose parents often visit the school is likely to behave well as the learner becomes aware that his/her parents often communicate with the teachers (Exposito, 1999:1). The parents should be aware of any activities that take place at school, and parent-teacher

conferences or meetings where the child's performance is the focus of attention, are important (Campbell & Verna, 2007: 503).

Epstein suggests that home-school communication should be a two-way communication and reflect a co-equal partnership between families and schools (Lemmer & Van Wyk, 2004). Furthermore, Epstein (1987) argues that the educator who works with parents understand their children better, generate unique rather than routine solutions to classroom problems and reach a shared understanding with parents and learners. Moreover, parents who are involved in their children's school work develop a greater appreciation of their role (McBride, 1991).

Overall, parental involvement in education has been associated with a variety of positive academic outcomes, including higher grade-points averages (Gutman & Midgley, 2000), lower dropout rates (Rumberger, 1995), fewer retentions and special education placements (Miedel & Reynolds, 1999), improved writing skills (Epstein, Simon & Salinas, 1997), higher level of achievement in mathematics (Izzo, Weissberg, Kaspro & Fendrich, 1999), and increased achievement in reading (Senechal & LeFevre, 2002).

2.4 THE PHYSICAL SCIENCE AND ITS IMPLEMENTATION

The section discusses the physical science curriculum and its implementation under a couple of sub-headings outlined below.

2.4.1 Physical Sciences Curriculum

By way of definition and conceptualization, Grayson, McKenzie, Dilraj & Harris (2005:x) describes the Physical Sciences as “fields of study that investigate the non-living parts of the universe”. In addition, they define the Physical Sciences as “the study of what everything is made of, the structure and properties of matter, the ways in which different kinds of matter interact, and different forms of energy”. In a nutshell, these authors surmise that all science is the result of human effort to understand the world around us (Grayson, et al. 2005: x).

The NCS Grades 10 – 12 (General) Learning Programme Guidelines for Physical Science states that:

Physical Sciences deal with societies’ need to understand how the physical environment works in order to benefit from it and responsibly care for it. All scientific and technological knowledge, including Indigenous Knowledge Systems (IKS), is used to address challenges facing society. In the subject Physical Sciences challenges such as the safe disposal of chemical waste, responsible utilization of

resources and the environment, alternative energy sources are addressed (Department of Education, 2005: 7).

According to the Department of Education (2005:7)

The purpose of Physical Science as stipulated in the NCS Learning Programme Guidelines Grades 10 – 12, is to equip learners with investigative skills relating to physical and chemical phenomena.

In this regard, Physical Science is meant to promote knowledge and skills in scientific enquiry and problem solving, the construction and application of scientific and technological knowledge, an understanding of the nature of science and its relationships to technology, society and the environment. Consequently the physical sciences should prepare learners for future learning, specialist learning, employment, citizenship, holistic development, socio-economic development, and environmental management. (Department of Education, 2005:7)

The Department of Education (2005:29) also maintain that

the physical sciences play an important role in the lives of all South Africans owing to their influence on scientific and technological development, which are necessary for the country's economic growth and social well being of its people.

Within the context of curricular progression, physical science in the FET band should build on the foundations laid by the Natural Sciences learning area in

the General Education and Training (GET) band. Learners in physical science are expected to develop the following competencies:

- Scientific enquiry and problem-solving skills,
- Construction and application of physical science knowledge, and
- Understanding of inter-relationship of physical science, technology, the environment and society, and of different attitudes and values (Department of Education, 2005:10).

According to the Department of Education (2005:10):

The envisaged Physical Sciences learner will be imbued and empowered with skills and knowledge for lifelong learning, and encouraged to pursue careers at tertiary level such as medicine, bio-engineering, psychology, nursing, education, marine biology and environmental sciences.

Accordingly, there are three learning outcomes and assessment standards for physical science, as summarised in Table 2.1 (Department of Education, 2003:13, 14):

Table 2.1 Thrusts of the Assessment Standards for each Learning Outcome

Learning Outcomes and Assessment Standards	Learning Outcome 1: Practical Scientific Enquiry and Problem-solving Skills	Learning Outcome 2: Constructing and Applying Scientific Knowledge	Learning outcome 3: The Nature of Science and its Relationship to Technology, Society and Environment
Thrusts of the Assessment Standards	Conducting an investigation.	Recalling and stating specified concepts.	Evaluating knowledge claims and science's inability to stand in isolation from other fields.
	Interpreting data to draw conclusions.	Indicating and explaining relationships.	Evaluating the impact of science on human development.
	Solving problems		
	Communicating and presenting information and scientific arguments.	Apply scientific knowledge.	Evaluating science's impact on the environment and sustainable development.

The Department of Education (2005:11-12) spells out that the ways to achieving the above learning outcomes are through the assessment standards. This, however, cannot be attained in a vacuum but through content and context. Core knowledge areas have been selected as appropriate content for the achievement of the learning outcomes. This

means that after identifying the learning outcomes and assessment standards that are to be addressed, the content and the context must be selected. These selections must create multiple opportunities for learners to achieve the espoused learning outcomes.

The assessment standards for physical sciences give guidance of the level and depth of the content to be used in achieving the stated learning outcomes. Thus, these assessment standards in physical sciences are a vehicle for the development of skills, values and attitudes which, in turn should be influenced by the issues of science and society, as well as Indigenous Knowledge Systems (IKS). This way, learners will realise the importance of science in their lives, as well as the fact that science has always affected various communities in some way through IKS (Department of Education, 2005: 11-12).

2.4.2 Instructional Approaches used in Teaching/Learning Physical Science

Teaching/learning and assessment are like two sides of the same coin in the sense that one cannot assess without teaching and vice versa. Coetzee (2008:91) asserts that "there seems to be a growing recognition of the need to refocus our instructional methods on meaningful learning and conceptual understanding of scientific ideas". Coetzee further maintains that "no single instructional method by itself adequately reflects the entire multidimensional

nature of understanding” (Coetzee, 2008:91). Wessel (1999) also agrees that no single instructional strategy should be considered as the ideal for redressing learning difficulties, although some choices, for instance small group instruction, facilitate student learning better than others. Coetzee maintains that the choice of instructional strategies depends on a number of factors, including teacher preferences, the concept being developed, classroom facilities, available sources and the group of students being taught (Coetzee, 2008:91).

The teacher coordinates a variety of learning activities, for example, enquiry task with questions, short formal lecture, problem-solving session, group discussion. Closed-ended result-focused activities may reinforce earlier learning but do little to encourage new understanding (Cooper, 2002). When students become comfortable with being actively involved in their learning, they are incredibly active – manifesting in numerous interactions between participants, spontaneous conversations among students and between students and the teacher, discussion of ideas with each other, openly arguing about interpretations and meanings of definitions, concepts and problems (Wessel, 1999). Learner-centred active instruction and interactive engagement lead to conceptual change (Gray, 1997; Von Glasersfeld, 1989). Gray (1997) further maintains that the educator provides learners with experiences that allow them to hypothesize, predict, manipulate objects, pose questions, research issues, investigate, imagine, invent and reason.

The following is a brief description of the behaviourist and constructivist learning theories which form the basis of a conceptual framework for learning and teaching in science education.

2.4.2.1 Behaviourist Learning

In the behaviourist approach to learning, the emphasis is on controlling those behaviours of the learner that can be observed and measured and could be best served through the following instructional strategies: direct instruction, whole class teaching, lecture and demonstrations (Reddy, Ankiewicz & de Swardt, 2005:18).

Gunter, Estes and Schawb (1995:60), point out that “the direct instructional strategy is widely applicable and can be used to teach concepts, factual knowledge and basic skills”. They further state that “this strategy places the teacher at the centre of instruction” (Gunter, Estes & Schawb, 1995:60). According to Eggen and Kauchak (1996:181), “when the direct instructional approach is used the teacher assumes major responsibility for structuring the content or skills, providing opportunities for practice and giving feedback”. As Gunter, et al. (1995:73) state

Every teacher, of every subject/learning area, at every level of schooling has some learning outcomes related to the acquisition of factual knowledge and the mastery of basic skills before the learner can move to higher level of thinking and learning.

As part of direct instructional strategies, Gagne and Biggs (1972:95) assert that “demonstrations by the teacher are important for learning”. This strategy is based on the idea that skills are acquired as a result of learners observing how things are done, and then practising the skills for themselves under the supervision of the teacher.

Whilst practical problem solving is central to science education, Down (1996:233) states that there are numerous things that need to be learnt in the ‘transmission mode’ of teaching which need not involve problem solving methods. Instructional practices that lead to the enhancement of intellectual skill development could depend on an understanding of constructivist learning theories (Reddy, et.al. 2005:19).

2.4.2.2 Constructivist Learning

It is popularly claimed that learning is an active process of knowledge construction on the part of the learner (Reddy, *et al.*, 2005:19). The popular view is that constructivism is synonymous with approaches to learning that are progressive and learner-centred and is a ‘welcome antidote to traditional approaches’ (O’Loughlin, 1992: 336). According to McCormick (1997:148), “constructivism focuses upon individuals building up representations of their knowledge, which is then tested against experience”.

Arising from the constructivist instructional approach are various sub-approaches and concomitant instructional strategies. The sub-approaches include cooperative learning, discovery learning, enquiry and experiential learning. Instructional strategies associated with cooperative learning, for example are, group work, discussion, debate and role play (Wheatley, 1991:10; Johnson, 1997:172; Banks, 1996:10).

2.4.2.3 Categories of Learner Experience

Categories of learner experience are briefly discussed below under a couple of sub-headings.

2.4.2.3.1 Factual knowledge through direct instruction.

In science education like most other subjects and learning areas, there exists a body of knowledge (Dugger, 1997:126-127) that needs to be acquired before learners are in a position to apply this knowledge to problem solving activities. The ability to apply basic conceptual knowledge gained through direct instruction requires self-confidence. Self-confidence in turn implies empowerment which is directly linked with self image (Coetsee, 1992:24).

2.4.2.3.2 Basic manipulative skills through direct instruction

Basic manipulative skill development forms an integral part of the realization of design solutions and this can only be acquired through practice (Mawson, 2003). Manipulative skill development in physical science is linked to empowering learners through hands-on exploration in the context of science problem solving. Johnson (1997:167) asserts that “manipulative skills should be developed through the use of tools, equipment and materials in focused practical tasks and activities”.

2.4.2.3.3 Co-operative learning as an approach in science education.

A number of researchers (Cavalier, Klein & Cavalier, 1995; Johnson & Johnson, 1989; King, 1984) have found that group interaction behaviour is related to improved performance when co-operative instructional approaches to learning are used. Through the exchange of ideas, learners develop shared meanings that allow group members to communicate effectively with each other (Wheatley, 1991:19). By interacting with others, learners have the opportunity to learn from each other, share knowledge, engage in competition, co-operation, collaboration, conversation and negotiation of meaning (Johnson, 1997:171).

One particularly important development in schools has been the greater use of small group work. Small group work refers to academic tasks and activities

undertaken by a group of pupils, which involves some degree of discussion, reflection and collaboration. The optimum size for small group work for most types of tasks is probably about five (Waterhouse, 1983) although other types of group work can be undertaken by groups as small as two.

Whitaker (1984) lists the value of small group work as follows:

- It creates a climate in which pupils can work with a sense of security and self-confidence;
- It facilitates the growth of understanding by offering the optimum opportunity for pupils to talk reflectively with each other; and
- It promotes a spirit of co-operation and mutual respect.

2.4.2.3.4 Discovery learning as an approach to learning in science education.

This approach involves the discovery by the learner of what he/she is capable of thinking and doing for himself/herself (Bruner, 1996:106). In order to achieve discovery, the learner must incorporate and integrate information with what is already known as new relationships are formed (Biehler & Snowman, 1993:425). According to Mwamwenda (1995:213), "discovery does not necessarily mean coming up with knowledge that is unknown to someone else but coming up with knowledge by oneself". An important component of discovery in learning is the discovery of relationships between parameters (Biehler & Snowman, 1993: 427). In essence, discovery learning involves

rearranging or transforming information so as to obtain new insights. Given the problem solving nature of science education, the discovery approach to learning is a valid form of knowledge construction, whereby learners take responsibility for their own learning. Roth (1990:155) asserts that "learners have opportunities to explore their own ways of thinking about the phenomena under discussion".

2.4.2.3.5 Enquiry-based learning as an approach to learning in science education.

Enquiry-based learning is whereby the learner questions, investigates and seeks out information, thereby assuming responsibility for his/her own learning, with the teacher playing a facilitator role. According to Eggen and Kauchak (1996:236), "involving learners in inquiry learning is one of the effective ways to help them develop their higher-order and critical thinking skills", leading to empowerment. Schwaller (1995:438) maintains that "enquiry learning is an investigative learning process which is often equated to experimentation, discovery and problem solving". Duke (1990:57) claims that "it is more important that learners become familiar with the enquiry process than to obtain the correct answers". It is the view of Orlich, Harder, Callahan, Kauchak and Gibson (1994:271) that "the enquiry process must be learnt, demonstrated and assimilated into learning styles".

Anderson (2002:1), in his study makes a link between enquiry teaching and constructivism. "Inquiry ... characterizes good science teaching and learning. Constructivism had entered ... as the descriptor of good education". However, Anderson chose to stay with enquiry and ignored the new word (constructivism) (Coetzee, 2008:87). According to Anderson (2002:1), teachers considering new approaches to education face many barriers and dilemmas, many of which have origins in their beliefs and values which are connected to constructivism. He lists them as follows:

- Limited ability to teach constructively due to inadequate in-service education which is not sustained for a sufficient number of years;
- Prior commitments to textbooks and coverage of content because of a perceived need to prepare students for the next level of schooling;
- The challenges of new teacher and student roles;
- The challenge of assessment;
- Difficulties of group work;
- Parental resistance; and
- Lack of resources.

Coetzee (2008:88) asserts that Anderson's list is compatible with the issues educators have experienced in South Africa with the OBE implementation.

2.4.2.3.6 Experiential learning as an approach to learning in science education.

Experiential learning is considered to be a powerful and empowering tool to making science education more meaningful and relevant to the lives of learners (Reddy, *et al.*, 2005:29). According to Johnson (1997:47),

Current approaches that emphasize experiential learning include among other things, discovery learning, inquiry learning, activity based learning, project based learning, action learning and hands-on experience.

Johnson further states that each of these approaches emphasizes the importance of learning from experience, that is goal-driven, activity based and problem centred. Down (1996:233) points out that “one reason why learner centredness stresses problem solving as opposed to direct instruction is that learning from experience is a more active and valid form of learning”. Henak (1992:14) stresses that “meaning is added when learners are actively involved in learning experiences”. Meaning, according to Henak, can come from activities that are relevant to real life problems. However, it does not mean that if there are no activities done by learners, there is no meaningful learning. Learning can be meaningful even if the learner is listening to a lecture by the educator. Listening skill is one of the skills that should be developed in the learners. It can be concluded therefore that whatever instructional strategies are employed by educators, they should lead to meaningful learning.

It is important to make a clear distinction between receptive and discovery learning, and between rote and meaningful learning so that there is no confusion as to how learners learn. Ausubel makes a distinction between rote and meaningful learning, which is important for teaching higher order thinking (Ivie, 1998). Ivie (1998) states that rote learning occurs when the learner memorizes information in an arbitrary fashion. The knowledge or information is stored in an isolated compartment and is not integrated into the person's larger cognitive structure (Ivie, 1998). According to Ausubel (1962:215-216), "rotely learned materials are discrete and isolated entities which have not been related to established concepts in the learner's cognitive structure". Rote learning is easily forgotten because it is not anchored to existing concepts. According to Ausubel (1978), rote learning does not involve subsumption (i.e., related to meaningful materials).

On the other hand, Ivie (1998) states that meaningful learning is part and parcel of higher order thinking. Such thinking takes place when the interrelationship between two or more ideas, old and new, is grasped. In this regard, Ausubel and Robinson (1969:46) contend as follows:

A first prerequisite for meaningful learning is that the material presented to the learner be capable of being related in some 'sensible' fashion. Second, the learner must possess relevant ideas to which the new ideas can be related or anchored. Finally, the learner must

actually attempt to relate, in some sensible way, the new ideas to those which he presently possesses.

According to Ausubel (1978), in meaningful learning, the learner must discover information through problem solving, implying that if any of the three above-mentioned conditions is missing learning is not meaningful but rote. For this reason, Ausubel (1968) contends that, the most important single factor influencing learning is what the learner already knows. Indeed, teachers have always recognized the need to start instruction 'where the student is'.

Ausubel also gives further clarity on reception, discovery, meaningful and rote learning: Verbal reception learning is not necessarily antithetical to higher order thinking, though the method has been characterized as "parrot-like recitation and rote memorization of isolated facts" (Ausubel, 1963:15). Reception learning is not invariably rote; likewise, discovery learning is not always meaningful. Either reception learning or discovery learning can lead to rote or meaningful learning (Ivie, 1998). In this regard, Ausubel (1961: 17) states that "the learning outcomes must necessarily be rote and meaningless" if the learner merely memorizes the material (even if the conclusions have been arrived at by the discovery method) (Ivie, 1998). It's for this reason that Reception or Discovery learning may promote either rote or meaningful consequences. One does not inherently infer the other. Ivie (1998) further

maintains that the whole question of rote learning versus meaningful learning depends upon whether or not the new information is integrated into the learner's cognitive structure in an enduring and meaningful way.

2.4.2.4 Importance of Blended Teaching

Based on the above views on learning, there must be therefore a continuum in the methods of teaching used by educators, that is, in one lesson the lecture method can be followed by a demonstration, then question and answer method, and so on. Methods of teaching are not discrete but interrelated. One method is used in conjunction with another. For example, while an educator is doing a demonstration to clarify a concept, at the same time there are a lot of explanations (lecture method), questions being asked and learners giving answers (question and answer method). In the same lesson the educator may allow learners to practise the same skills after a demonstration (hands-on exploration). Therefore, no method of teaching is an island.

2.4.3 Facilities and Resources

On the issue of facilities and resources, Adler and Reed (2003:54) make the following observation:

In schools with limited infrastructure there is not only little to draw on for learning and teaching, but conditions actively detract from the possibilities for focused attention on learning and teaching. A central

educational challenge in South Africa, alongside the implementation of a new curriculum, is thus the provisioning and (re)distribution of human and material resources for learning and teaching in schools.

The school Register of Needs (Bot, 1997) revealed that 17% of all schools in South Africa lacked basic physical infrastructure. There was a serious overcrowding in some of these schools, with classes of up to 100 learners, and in 23% of schools there was neither running water nor any toilet facilities in the school (Adler & Reed, 2003:54). Consequently, Adler and Reed (2003:58) contended that the “difficulty with change in educational practices are attributed to ‘lack of resources’”. Adler and Reed further asserted that :

any attempts to change practices, be they in the wider mathematics, science and language education fields intentionally, or in the more politically charged South African context, will bring with them new and different resources or new uses for existing resources – and , perhaps more substantively, a re-sourcing of the practice.

Assessment is also influenced by physical resources, such as, classroom shortages that lead to overcrowding, availability of laboratories, teaching and learning material and equipment, etc. The 1980-81 Board of Directors of the National Science Teachers Association (NSTA) unanimously adopted the following statement regarding the place of the laboratory in science education:

The National Science Teachers Association endorses the *necessity* of laboratory experiences for the teaching and learning in science. Adequate support for materials, equipment, and teacher time must be available for schools to maintain quality science instruction. Such a quality programme is critical in today's age science and technology (Klein, 1982:20).

Klein (1982:20) further asserts that "the significance of the laboratory is being questioned at every level of science teaching". Although it is not possible to attest to the value of every situation called a "laboratory" in every science course, it is fair to insist that science classes must include a significant component that demands direct experience with science. Consequently, Klein points out that "textbooks, recitations, worksheets, traditional tests, films and many other activities that characterize much science instruction cannot replace active science" (Klein, 1982:20). Extending the above point as a way of emphasizing the role of the laboratory in physical science teaching, in particularly, Klein avers that "science is more than learning information that appears on the printed pages of science texts" (Klein, 1982:20).

In support of the above argument, Tafel also points out that "scientist, professors of science education, and science teachers agree that there is only one effective method for teaching science to the early adolescent – the use of the laboratory and hands-on materials" (Tafel, 1982:20). According to

Lunetta, (1982:21), "activities in the high school science classroom and laboratory involve students in developing and using such skills as:

- Recognizing problems;
- Selecting and using appropriate procedures for collecting data on problems;
- Manipulating materials and satiations in order to make relevant observations;
- Drawing inferences, generalizations, and concepts from data;
- Explaining known relationships in nature and predicting the unknown;
- Applying information; and
- Communicating with other to resolve problems".

For this reason, Lunetta maintains that "the use of activities in science teaching and learning can promote intellectual development and problem solving skills" (Lunetta, 1982:21). This implies that such activities are essential because they provide direct experience with science and without them students acquire a distorted and narrow view of science. Furthermore, Lunetta posits that "science activities can be powerful tools for developing reading and mathematical skills" (Lunetta, 1982:21). In addition to helping solve scientific problems, Lunetta argues that:

Laboratories offer opportunities for science students to learn to become better observers, more careful thinkers, better users of information,

more deliberate problem solvers, more curious people in relation to their environment, and more logical thinkers in approaching the unknown. Laboratories can also motivate students, while at the same time assist them in the development of reasoning as a basic skill.

By way of definition, Perez (1982:20) sees laboratory as “the *place* for real science teaching and *approach* to science that is so vital if students are to experience the meaning of science directly. The laboratory provides students with an opportunity to *do* science rather than to learn *about* science”. There are in fact many ways to learn about science, that is, from textbooks, discussions, demonstrations, films, and more. The laboratory however, “is the only way for students to become involved with the processes that characterize science as a discipline” (Perez, 1982:20)

The laboratory gives students firsthand experience with enquiry, the search for order and meaning in the natural environment. Without laboratory experiences, “the science classroom is reduced, at best, to secondhand experiences” (Perez, 1982:21). Perez further describes the laboratory as “the place where students can learn skills for living, including those associated with decision making and problem solving” (Perez, 1982:21). According to Jenkins (2007:724), “laboratory experiences provide opportunities for students to interact directly with the material world (or with data drawn from the material world), using the tools, data collection techniques, models, and

theories of science". Jenkins further states that "the teaching of scientific skills, processes, and competencies are all commonly associated with the goal of teaching 'scientific inquiry'" (Jenkins (2007:730). Consequently, Jenkins further posits that "such inquiry is seen as fundamental to scientific literacy; engaging students in inquiry-based activities is regarded as a means of helping them to understand the nature and the limits of science-based knowledge of the material world". Leach (1998:58), views the laboratory experience as follows:

The objects of science are essentially the products of human representation and no laboratory experience or set of experiences can lead students directly to the metaphors, images and concepts that characterize scientific discourse. At best, laboratory experiences can help persuade students of the validity and utility of those metaphors, images, and concepts, but they cannot establish them. Many students assume that scientific experiments are conducted independently of such constructs and this assumption, by no means confined to school students, shapes their views and beliefs about the nature of science and, in particular, about why they are engaged in laboratory work.

Hurd contends that "laboratory experience has one dimension in science as a research process and another dimension in those social processes by which science contributes to human welfare" (Hurd, 1982:22). Laboratory experiences enable students to do science by providing an opportunity for

them to seek information using experimental procedures. By way of definition, Hurd perceives a good experiment as “an invitation to careful observation, thought, and interpretation”. Hurd further maintains that a good experiment is “characterized by the qualities of questioning and investigating, a confrontation with the unknown – in contrast to programmed routines assuring a predetermined answer” (Hurd, 1982:22). This therefore implies that a desirable experiment is an exercise in logical thought and intellectual action rather than a performance.

Bates (1982:22) suggests that there are at least five types of laboratory experiences, all differing significantly in function, structure, expected outcomes, and method of assessment. The five types are:

- (1) *exploration*, in which students learn how to observe phenomena;
- (2) *operational*, in which students use accepted procedures to gather data;
- (3) *deductive verification*, in which students infer a measurement, e.g. the mass of an electron, by obtaining data which is inserted into an derived from current theory by deductive logic;
- (4) *inquiry*, in which students explain some novel phenomena according to the concept being studied, and
- (5) *process*, in which students design and evaluate an experiment.

The “lack of equipment and facilities is a common complaint among physical science teachers who may not realize the wealth of natural phenomena that

could easily, and perhaps more adequately, explain textbook and lecture material" (Tilgner, 1982:43). To overcome this problem Tilgner suggests that "science educators must analyze the each situation and work within the bounds of the system to correct deficiencies" (Tilgner, 1982:43). Tilgner further posits that science educators

must be more aware of available materials and methods; they must convince the public that science is important and should be an integral part of every student's educational programme; they must offer physical science courses that are not divorced from students' experiences in the real world.

Helgeson, et al (1978) also contends that science educators must make the case that physical science is basic and applicable in any vocation.

Improvisation is another way of overcoming facility problems, as Butler (1998:96), states "many educators make their own teaching resources." Butler goes further to say that "they usually do this because there is not enough other resources in the school for them to use", and that "educator-made resources are often more directly relevant to learners' needs than commercially published ones". Butler (1998:84) points out that "curriculum resources include anything an educator can use in his or her classroom which benefits learning and teaching". He further observes that learning and teaching could not take place without curriculum resources". Therefore, as has already been pointed out, implementing OBE which is a resource-

intensive curriculum innovation puts an added pressure on using additional curriculum resources.

2.4.3.1 The Involvement of Business and Industry with Education

In addressing the paucity of resources for teaching physical science, it is important to realise that schools cannot solve all educational ills on their own. Schools have as much to offer industry, as industry has to offer schools (Banham, 1989:11). As such, partnerships between education and industry have much to offer all parties involved. According to Pretorius (1993:130-131), partnership benefits for learners include:

- Work experience;
- Stimulation in a subject / career using industrial resources;
- Academic work which relates to the demands of the working world;
- Motivation;
- Special events, e.g. competitions or business games; and
- Business sector can also donate, build laboratories, help the school with science kits if requested to do so.

Benefits for educators include:

- Attending company training courses;
- Attending education-based courses with industrial contributions;
- Use of up-to-date material in classrooms;

- Developing and maintaining personal contacts;
- Expert assistance from business for policy-making, resource allocation and strategic management;
- Information about the needs of the workplace for the purpose of curriculum development; and
- Use of experts from business and industry as part-time or temporary full time teachers.

Benefits for business and industry include:

- Educated and well-prepared workers;
- Use of facilities, equipment and other resources of educational institutions;
- Direct economical benefit arising from educational institutions buying goods and services from their local communities;
- Help in applying technology to improving business operations;
- Up-to-date information about developments and new approaches in education; and
- Better understanding of problems in education provisioning (Pretorius, 1993:130-131).

2.4.3.2 Management of resources

It is the view of Butler (1998:86) that “many principal and SMTs are unaware of the vast curriculum resources the school already has. The first step to managing curriculum resources is related to organizing the resources the school already has”. The resources the school has available and the way they are managed are very important. “This is because the nature and quality of the curriculum offered at the school depends largely on resources and their management” (Butler, 1998: 88). The SMT (including the principal) should encourage the wide involvement of other members of the school community in the acquisition (getting) of additional resources. “While the SMT manages the school’s resources, everyone needs to appreciate and care for them” (Butler, 1998: 84). Resources also need to be planned in the annual school budget.

The following are some of the ways of managing school resources according to Butler (1998:88):

- Identify all resources in the school by giving them name and number;
- Use a register to record the names and numbers of resources;
- Use local resources wherever possible;
- Offer staff training on how to use the resources;
- Store some of resources in the classrooms that can be locked;
- Keep some resources in the administration block; and
- Quickly repair any resources that break.

According to Butler (1998:98) “physical resources need to be controlled in the school by a stock controller. The stock controller’s responsibilities include:

- Checking resources when they arrive at the school;
- Cataloguing all the resources;
- Making resources available by issuing them;
- Repairing damaged resources; and
- Monitoring educators and learners who are issued resources.

After the release of 2008 matric results on (Wednesday, 31/12/2008) educationists, politicians and other people with interest in education made various comments about poor results in mathematics and physical science. Educationists made the following comments with regard to resources and educator support:

University of KwaZulu Natal analyst Renuka Vithal said that although rural schools still carried the legacy of apartheid, they also lacked resources (Vithal, 2008: 2). “I think the new curriculum demands a very high level of skills which is needed by all learners equally”, said Vithal. Vithal further stated that “the problem is not with the curriculum but with the pace of resourcing in our rural schools. Our rural schools need skilled teachers, more access to the material such as computers. Books are needed for pupils to pass”. Vithal

pointed out that “the Education Department had been quick to change the curriculum but too slow to address the poor condition of the schools in the rural areas.” She said the Department of Education should focus on rural schools’ resources (The Mercury, Wednesday, 31 December 2008:2).

The media stated that rural high schools in KwaZulu-Natal had borne the brunt of the changes in the school curriculum, scoring the lowest pass rate in the 2008 matric final examinations. The KwaZulu-Natal Education Department Head, Cassius Lubisi (2008:2) also concurred that “the legacy of apartheid still exists”. He further stated that clearly, educational opportunity was still determined by socio-economic status. He posited that “if you live in rural areas where there is no water, where parents have income levels close to zero, your chances of passing are seriously compromised”. The media stated that “pupils had serious problems with physical science. Over 52 000 wrote, around 25 000 passed.” This is supported by the fact that learners from former Model C schools did well in their matric results. These included St Catherine’s High School, John Ross College, Felixton College, Empangeni High School, Hoerskool Richardsbaai and Grantleigh College in the Empangeni District (Zululand Observer, 2009). This underlines the importance of proper resourcing of schools as a determinant of success.

2.5 THE RANGE OF ASSESSMENT STRATEGIES AVAILABLE FOR USE BY EDUCATORS

The NCS specifies the Learning Outcomes (LOs) and the Assessment Standards (ASs) for each subject. Teaching/learning and assessment are like the two sides of the same coin. It is therefore imperative for educators to use the assessment strategies that help in the achievement of the LOs. In exploring the range of possible assessment strategies which could be used by physical science educators, a number of sub-headings have been identified.

2.5.1 Outcomes-Based Assessment

Assessment in the NCS is an integral part of teaching and learning. For this reason, assessment should be part of every lesson and teachers should plan assessment activities to complement learning activities. In addition, teachers should plan a formal year-long programme of assessment. Together, the informal daily assessment and formal programme of assessment should be used to monitor learner progress through the school year (Department of Education, 2005:1)

Outcomes-based Assessment (OBA) largely implies individual assessment based on the teacher's observation of an authentic task performed by the learner. As an integral part of learning, assessment involves attention to four concerns, namely: "Clear teaching and learning aims; motivation; previous experience and present abilities; and effective tasks and flexible teaching methods" (Education Department, 1991:12).

In OBE, the emphasis in assessment is on continuous diagnostic assessment of the learner's work over a period of time, rather than on performance in a once-off examination or test. This approach to teaching and learning is aimed at ensuring success through intervention that will support the learner in the accomplishment of clearly stated outcomes and instructional interventions appropriate for the learner's stage of development. Thus, the methods teachers use to assess what students' competences can reinforce a way of thinking about science.

In its simplest form, "assessment refers to collecting data about what learners understand and can do, evaluating those data, and making decisions based on that evaluation" (Dougherty, 1997:29). It is further stated that "if, however, teachers use assessment data only to inform students, their parents, or the school administration of what students know, then much of the power of assessment as a learning tool is lost" (Dougherty, 1997:29). In addition, Dougherty (1997:29) states that "teachers should use assessment in two equally important ways: (a) to evaluate periodically students' cumulative knowledge and understanding, a process known as summative assessment; and (b) to evaluate continually students' progress in learning, a process known as formative assessment." All teachers are familiar with summative assessment, the results of which are reflected in student report cards, but few pay much attention to formative assessment, which has the potential to drive

changes in teaching that can improve students' conceptual learning drastically (Dougherty, 1997:29). In addition, the emphasis on learning through assessment mitigates the perception that tests are tricks and places a greater responsibility on students for directing their own learning (Stiggins, 1994).

Physical science focuses on investigating physical and chemical phenomena through scientific enquiry. By applying scientific models, theories and laws, it seeks to explain and predict events in our physical environment. The focus of most student assessment should, therefore, be formative to encourage and guide continual learning. This means that daily assessment should be used to give feedback to learners as to their strengths and weaknesses and help them to develop strategies to improve their learning. It should also be used to help the teacher teach more effectively by developing a better learning programme which speaks to the needs of the learners – as well as their stages of intellectual development (Department of Education, 2005:7).

According to the Department of Education (2005:7), assessment tasks should focus on the following in an integrated manner:

The learner's ability to use process skills, critical thinking, scientific reasoning and strategies to investigate and solve problems in a variety of scientific and technological, environmental and everyday contexts (Learning Outcome 1). The learners' demonstration of enquiry skills, like planning, observing, collecting data, comprehending, synthesising,

generalising, hypothesising and communicating results and conclusions. The learner's ability to state, explain, interpret, evaluate and apply scientific and technological knowledge in everyday context (Learning Outcome 2). The learner's ability to identify and critically evaluate scientific knowledge claims and the impact of this knowledge on the quality of socio-economic, environmental and human development (Learning Outcome 3).

The requirements of OBE are that student assessment procedures should, of necessity, reflect the following attributes (Jacob, Luckett and Webbstock, 1999:122-123):

- Assessment should be based on human interaction and judgment;
- Student capabilities should be seen as a social construct;
- Educators should be aware of the possibility of multiple realities, hence multiplicity of possible competencies and capabilities (This contradicts the practice and notion of setting the same educational outcomes for everybody in a given programme of study);
- Educators should see intelligence/capability as being culturally and contextually dependent;
- Educators should use both formative and summative assessment to inform the instructional process, and ascertain the degree of attainment of intended outcomes;

- All aspects of learning (understanding, skills and values) should be assessed in an integrated way;
- Assessment should cover both the processes and products of learning;
- Assessment should concern itself with the use and application of knowledge, understanding, values and skills;
- Assessment should be continuous, and should cover internal and external issues pertinent to intended learning outcomes;
- Assessment should be made part of the instructional process;
- A diversity of assessment procedures and tools should be used, e.g. projects, portfolios, self-assessment and peer assessment; written and verbal;
- Both qualitative and quantitative descriptions/ measures of performance should be used;
- Learning outcomes to be made explicit to learners; and
- Cultivation of a culture of life-long learning.

In OBE, assessment should be done daily and continuously since it cannot be separated from teaching and learning. Assessment and learning are therefore two sides of the same coin.

An outcomes-based system relies on a clear set of learning outcomes on which the curriculum, learning facilitation and assessment are focused. The

outcome provides the facilitator with a starting point and focus on the curriculum, instruction and assessment (Betts & Smith, 1998:52). Similarly, outcome is shared with, and explained to, the learner on a continuous basis to ensure that the 'transparency' philosophy on OBE is fully realised (Schwarz & Cavener, 1994:328; Spady, 1994:9). In addition, OBE focuses on the philosophy of success for all learners with learners exiting successfully from the educational system (Spady, 1994:9). Thus, Barr and Tagg (1995:11) maintain that a learning environment is created that is challenging, co-operative, collaborative and supportive. This creates a win-win situation where success in learning is attainable. The learner experiences success in learning by attaining outcomes that promote more success and lead to expanded opportunities in learning (Schwarz & Cavener, 1994:329; Spady, 1994: 9). The expanded opportunities for learners to attain outcomes in the OBE approach consequently encourage the high expectations of learners (Schwarz & Cavener, 1994:328).

To be successful in practising a profession, Spady (1994:55) argues that the learner requires specific knowledge and then integrates and applies the knowledge within a specific content. This feature of the OBE approach, namely that key life skills should link to experiences in the real world, makes it very relevant to learners, their families and future employers (Spady, 1994:55). It therefore encourages learners to demonstrate more complex and

long-lasting learning compared to traditional assignments and pencil and paper tests (Spady, 1994:55).

The assessment process must be conducted to contribute to the learning experience of the learner (Spady, 1994:103). To contribute to the learning experience and to provide the learner with a greater chance to succeed, Cunningham (2002:258) adds that attention should be paid to providing better feedback on assessment and on providing remediation activities to learners. In the same vein, Bligh (2001: 74) mentions that assessment should discover what the learner has learnt, rather than what has been taught. Assessment therefore should reflect as closely as possible the actual tasks performed, termed authentic or performance assessment (Brown, Race & Smith, 1996:74; Bligh, 2001:312). Ben-David (1999:23) argues that performance assessment and OBE are closely related paradigms because these approaches are bound by simple educational principles, namely that assessment methods should match the learning modality. Assessment in the OBE approach is a continuous process based on a holistic and integrated approach to facilitate learning. Assessment should therefore be conducted in a manner to enable progress and academic development of the learner.

2.5.2 Principles of Outcomes-Based Assessment (OBA)

The following important concepts must be first explained: *assessment approaches*, *assessment strategies* and *assessment agents*. The term

assessment approach is used in this study for diverse approaches including categories of classification; forms of assessment such as norm-referenced and criterion-referenced assessment; formative assessment, summative assessment, among others. *Assessment strategies* are used in this study for different methods, types or tools of assessment. Clark (1996:336) argues that “strategies are conceived at the level of organization and structure”. He continues to say that “tasks are conceived at the level of activities”. Examples are well-known traditional assessment instruments or tools such as portfolios, journals, and activity checklists (Maree & Fraser, 2004:48,49). Assessment agents involve the actions of the interested parties and may include educators and learners, policy makers and academics, as well as parents and the community (Maree & Fraser, 204:49).

According to Maree and Fraser (2004:51-53) assessment strategies used in the outcomes-based assessment are:

Objective tests (selected response tests or ‘pen and paper’ tests) require structured learner responses. Major types include supply type (short answer and completion), and selection type (multiple choice, true/false and matching). *Essay tests* require responses that are either restricted-response tests or extended-response tests. Essay questions provide the freedom of response that is needed adequately to assess the ability of learners to demonstrate reasoning abilities and to apply skills in order for educators to interpret complex achievement.

Personal communication: This strategy of assessment may take a variety of forms, including instructional questions and answers, oral examinations, interviews and journals.

Performance-based assessment (performance assessment): This strategy requires the demonstration of skills or proficiency through creating, producing or doing something, often in a setting involving real-world applications. The emphasis is on doing, not merely on knowing, on process as well as on product. This strategy is mostly widely used to assess abilities of learners under given conditions and instructions.

Assessment in OBE is outcomes based. To ensure that the assessment is in line with the principles of the NCS and that there is equality of opportunity and no discrimination or bias in respect of gender, race, disability or even social class, the following principles as outlined by Prinsloo and Van Rooyen (2003:34-36):

Transparency: Something is transparent when it is clear to everyone who uses it. So, the assessment process must be clear and open to the learners. A learner must have a right to question and appeal the assessment procedure.

Validity: Assessment must assess what it claims to assess. Educators as assessors should be fully aware of what is to be assessed as indicated by the unit standard or learning programme, the performance outcomes and the assessment criteria. Evidence is collected from activities and tasks that can

be clearly related to the capability or performance outcomes specified for learning programme or unit standard.

Evidence should demonstrate that performance outcomes have been met and is gathered in an integrated fashion within the context of work to be assessed. Assessment procedures, methods, instruments and materials have to match what is being assessed. The kind and amount of evidence required should determine the assessment that should be used and selected. The assessment should be within the parameters of what is required, not less or more than required by unit standard or learning programme. According to Prinsloo and Van Rooyen (2003:35), in order to achieve validity in assessment, assessors should:

- State clearly what outcome(s) is (are) assessed;
- Use an appropriate type or source of evidence;
- Use an appropriate method of assessment; and
- Select an appropriate instrument of assessment.

Reliability: Reliability in assessment refer to the same judgements being made in the same or similar context each time a particular assessment for specified stated intention is administered. Reliability instils confidence, that the interpretation is consistent from candidate to candidate and from context to context. To ensure reliability, high standards should be set. The process of assessment should be well documented, and unambiguous procedures should be in place. To avoid variance in judgements, assessment should

ensure that each time an assessment is administered the same or similar conditions prevail and the procedures, methods, instruments and practices are the same or similar.

Consistency: Assessment should produce consistent outcomes. To ensure consistency it is important that the assessment procedures are simple, clear and well documented. The assessment criteria should be clear and unambiguous. Assessor should be well trained and consistently briefed for their tasks. Multiple assessors and panels must be used and multiple parallel forms of evidence are used to measure the same capabilities.

Practicability: Practicability refers to ensuring that assessment takes into account available financial resources, facilities, equipment and time. Assessment that is too costly may cause the assessment to fail.

Fairness and Flexibility: assessment is fair if it does not disadvantage anyone. It should be accessible to all people regardless of age, gender, ethnicity, disability, language barriers and geographic location. The assessment process should be transparent, clear and available to everyone. All learners should understand exactly what is being assessed. Assessment practices should be flexible enough to accommodate the scope of knowledge and skills covered by assessment criteria, variation in context, the range of needs and personal circumstances of all potential candidates.

Sufficiency: There must be enough evidence to assess the learners. For example, one question for one test is enough to judge that a learner cannot

make the grade. The assessment must be sufficiently rigorous to challenge the learner to show that he/she knows, can think or do.

Manageability: Special care should be taken not to overburden learners, or the educator with the number of assessments or requirements for assessment tasks.

2.5.3 Continuous Assessment

Continuous assessment (often abbreviated as CASS) is an assessment strategy that bases decisions about learning on a range of different assessment activities and events that happen at different times throughout the learning process. In this regard, CASS involves assessment activities that are spread throughout the year, using various kinds of assessment methods such as tests, examinations, projects and assignments to name, but a few. Ideally, the different pieces of evidence that learners produce as part of continuous assessment are collected into a portfolio (Department of Education, 2005:12).

Consequently, CASS through informal daily assessment and the formal programme of assessment, should be used to:

- Develop learners' knowledge, skills and values;
- Assess learners' strengths and weaknesses;
- Provide additional support to learners;
- Revisit or revise certain sections of the curriculum; and
- Motivate and encourage learners (Department of Education, 2005:1)

According to Roth (2003:40),

“assessment and evaluation of student achievement is one of the fixed and unavoidable – for both teacher and student – elements of the school and of instruction”. It is further stated that “ assessment and evaluation are also important for the individual teacher for the purpose of diagnosing pre-suppositions in learning and the results of learning on the part of students, for advising students and parents, and last but not least, for evaluating and checking the effectiveness of the teacher's instruction”.

Within the context of South Africa's OBE, CASS occupies the centre piece of learning.

2.5.3.1 Advantages of Continuous Assessment

Arder, Rossouw, Lomofsky and Oliver (2004:109) and Coetzee (2004:43-44) identify advantages of Continuous assessment (CASS) to both educators and learners as follows:

- The awareness of learners' progress is not confined to one or two tests in a year but to a series of activities of one in class;
- Learners get to know how they are progressing in their learning;
- In the past, learners were disadvantaged when they missed a test or tests due to sickness or other causes. This is no longer a problem as learners are assessed continuously;

- Using only tests and examinations as assessment strategies was threatening to learners because that alone determined their success or failure;
- Using CASS strategies assists learners to correct their weaknesses as they learn. In other words CASS is both formative and summative, which means, the learner is not only promoted to the next grade on basis of final examination but also the work done during the course of the year is included in CASS.
- CASS makes it possible to assess qualities that are not assessed in traditional examinations;
- Both learners and educators are provided with feedback about learners' progress;
- CASS requires individual monitoring, which improves educator-learner-relationship;
- A variety of assessment methods, techniques and strategies are possible;
- A wide range of abilities, skills and attitudes could be assessed which enhances authentic assessment;
- Less focus is placed on memory work; and
- Examination stress faced by learners is reduced.

2.5.3.2 Daily Assessment

Learner progress should be monitored during learning activities. This informal daily monitoring of progress can be done through question and answer sessions, short assessment tasks completed during the lesson by individuals, pairs or groups or homework exercises. The teacher should consider which assessment tasks will be used to informally assess learner progress.

Individual learners, groups of learners or teachers can mark these assessment tasks. Self-assessment, peer assessment and group assessment actively involve learners in assessment. This is important as it allows learners to learn from, and reflect on, their own performance. The results of these informal daily assessment tasks are not formally recorded unless the teacher wishes to do so. In such instances, a simple checklist may be used to record the assessment.

Daily assessment activities should be designed to provide learners with opportunities to develop and sharpen their:

- Practical, scientific and problem-solving skills;
- Ability to construct and apply scientific knowledge; and
- Ability to identify and critically evaluate the contested nature of science and its relationships to technology, society and the environment.

(Department of Education, 2005: 2 & 8).

In addition to daily assessment, teachers should develop a Year-long Formal Programme of Assessment for each subject and grade. In grades 10, 11 and 12, the programme of assessment consists of tasks undertaken during the school year and an end-of-year examination. Grade 12 includes the trial examination. The marks allocated to assessment tasks completed during the school year will be 25% and the end-of-year examination mark will constitute 75% of the total mark. The marks achieved in each of the assessment tasks that make up the programme of assessment must be reported to parents. These marks will be used to determine the promotion of learners in grade 10, 11 and 12 (Department of Education, 2007:9, 10).

2.5.4 Assessment Methods

Assessment methods refer to a procedure to follow in assessing the learners. They address the question: who does the assessing and how? (Department of Education, 2001:24). Le Grange and Reddy (1998:3-4) state that traditionally it was only the educator who assessed the learner. Other than writing examination and seeing the mark they got, learners were never involved in the assessment process. Continuous assessment, as a requirement of the OBE system involves more than one assessor. It is no longer the business of the educator only (Gultig, Lubisi, Parker & Wedekind, 1998:29-30). CASS includes educator assessment, self-assessment, peer assessment, and group assessment. Other stakeholders outside the school who can be involved in assessing the learners are parents, district assessment team, the school

assessment team, occupational therapist, speech therapist and psychologist (Ngidi, 2006:33).

2.5.4.1 Educator Assessment

Educators have the overall responsibility to assess the progress of the learners in achieving the expected specific outcomes (Department of Education, 1998:16). This implies that educators have to consider the fact that a learner is now in a focal point of the system unlike in the past. Both the assessor and the assessment activity should be geared to the needs of a learner so that no barriers for further learning are created. If an educator OBA as spelled by the government, the transparency of an access to the assessment will be assured (Prinsloo & Van Rooyen, 2003:88-89).

Educators have to be sensitive to transformation by, *inter alia*, respecting the diversity on linguistic, gender, racial and cultural levels of the learners. Because the educators hold powerful positions, they have to identify the learner's needs and strengths in order to adapt their methods of instruction and assessment accordingly (Prinsloo & Van Rooyen, 2003:88-89).

Lubisi (1999:68) states that

“when an educator designs an assessment strategy, it is important to clearly indicate the times during the term or the semester, or the year

when particular assessment instruments would be administered to learners”.

Where certain assessment instruments are related, such relationships have to be clearly explained. Lubisi (1999:68) further states

it is possible to use one assessment method for different outcomes, and it is possible to assess learners in one outcome using various methods of assessments. It is up to the educator to select what he/she thinks would be useful when designing his/her assessment strategy.

Prinsloo and Van Rooyen (2003:88-89) identify the following skills/roles of the educator as an assessor:

- He/she will understand that the assessment is an essential aspect of the teaching and learning process and know how to execute his/her process;
- He/she will have an understanding of the purpose, method and effects of assessment and to provide helpful feedback to the learners;
- He/she designs and manages both summative and formative assessment in ways that are appropriate to the level and purpose of the learning and meeting the requirements of accrediting bodies;
- He/she will keep detailed and diagnostic records of assessment;
- He/she understands how to interpret and use assessment results to feed into the process for the improvement of learning programmes.

In addition, when assessing, the educator must make sure that the learners have everything they need before assessment begins. He/she must provide the learners with everything they need before assessment begins in order to assess what the learner knows and can do. He/she must give learners enough time for writing assessment tasks and also make sure that they understand the instructions. If the work is to be done at home the educator must make sure that the learner has the place to work at home. If he/she does not have it, he/she must be given time at school to write (Frazer & Maree, 2004:128).

It is the responsibility of an educator to give information about school assessments that should be used by stakeholders who in turn should make important decisions. The educator must ensure that the information given to the stakeholders is accurate and reliable. With this in mind he/she will be a competent assessor and a record keeper (Prinsloo & Van Rooyen, 2003:88).

2.5.4.2 Self Assessment

According to the Department of Education (2001:26),

this kind of assessment happens when a learner assesses his/her own performance against the desired outcomes and criteria and is able to decide what he/she needs to do to improve his/her own performance.

Le Grange and Reddy (1998:19) state that

Self-assessment happens when for example, an educator asks a learner to select his/her best history essay and state the reason for selection. This encourages self reflection on the part of a learner and enables a learner to take greater responsibility for his/ her own learning. Also an educator becomes aware of what a learner values as important and can provide him/her with more meaningful feedback.

Macmillan (2004:19) also states that

Self-assessment also works well when the result of the activity may be different from everyone. For example, a learner could conduct self assessment after reading a book, when describing his/her feelings or when evaluating learning. Self assessment is also useful when evaluating values and attitudes, especially where a learner may feel embarrassed if others read what he/she has written.

Goodman, Pienaar and Tobias (2005:31) advise that learners must be taught how to recognise, affirm and enjoy their achievements and reflect critically on their learning. Goodman, et al. (2005:29) also observe that self assessment helps the learners to:

- Recognize the learner process involved in teaching the desired goal;
- Identify effective learning strategies that they can apply in future learning;
- Change or adapt learning strategies;

- Set realistic goals for future learning;
- Plan their learning experience;
- Take control of their learning;
- Develop a sense of achievement; and
- Grow in self confidence.

Learners can therefore play an important role through self assessment, in “pre-assessing” work before the teacher does the final assessment. Reflections on ones own learning is a vital component of learning (Department of Education, 2001:26).

2.5.4.3 Peer Assessment

According to Jacobs, Gawe and Vakalisa (2000:285) “a peer is someone who is either the same age as you or in a similar position as you”. The department of Education, (2001: 26) and Macmillan (2004:19) define peer assessment as

a process of using learners to determine each others’ performance and achievements against clearly defined outcomes. Peer assessment may fall under the following categories: learner to learner, that is, where two learners assess each other’s performance; learner to group, that is, where the performance of a group is assessed by each learner; class to learner, that is, where the whole class assesses performance of other learners individually; group to learner, that is, where a group in class assesses an individual learner’s product; group to group, that is, when groups within one class assess each others’ performance.

Gultig, Lubisi, Parker and Wedekind (1998:29) take the above points further in the following observation.

By assessing their own work, the learners will develop better understanding of where they have gone wrong. This assessment enables the learners to keep track of their own learning. Learners will move away from only being interested in their marks to being interested in why they have done well or badly. It will also place learners in a powerful position to contest judgments made by educators as a result of assessment. Educators will, in theory, no longer have the monopoly in making decisions about their learners on the basis of assessment.

According to Gultig et al. (1998:29) it is important for the educator to state outcomes and assessment clearly before the learners begin to assess themselves so that they do not argue for a pass for a classmate who clearly cannot do the thing which has been defined as a required outcome. This could devalue their learning, when a learner who has not achieved the desired outcomes can be accredited. Ngidi (2006:42) asserts that "peer assessment is one of the outcomes based assessments which does not only concern itself with whether learners 'know that' but also concerned with whether learners 'know how' "

2.5.4.4 Group Assessment

The ability to work effectively in groups is one of the critical outcomes of OBE. Assessing group work involves looking for evidence that the group of learners co-operate, assist one another, divide work, and combine individual contributions into a single composite assessable product. *Group assessment* looks at process as well as product. It involves assessing social skills, time management, resource management and group dynamics, as well as the output of the group. Group assessment may be looked at in two different ways, first when a group assesses another learner, second, an educator assessing the entire group (Airasian, 1994:17; OBE assessment, 2001:29).

According to the Department of Education (2003, 2003:16),

group assessment is when groups within one class assess each others' performance on a given task within specified criteria, like, a group assessing a drama activity performed by another group. Group assessment involves assessing social skills, time management, resource management and group dynamics as well as the output of a group. Assessing group work involves looking for evidence that the group of learners co-operate, assist one another, divide work and combine individual contribution into a single composite assessable product. It looks at the process as well as the product.

There are some activities which are better done in groups like the following: Presentations, discussions, problem solving, project work, field trips, sharing ideas, etc. (Department of Education, 2003:17). Other than when a group assesses a learner, group assessment can also be used by an educator to assess the entire group (Airasa, 1994:17; Department of Education, 2001:29).

2.5.4.5 Parental Assessment

In this study, it was deemed important to examine the extent of family support received by students in their academic work. As already stated, the reason for this was that, as espoused, OBE relies on the home as an extension of school activities. According to Bester (2001: 50) the education of children is the joint responsibility of the educator and the parent. The parent is in partnership with the school. Therefore, the parent should also be involved in assessing the child's performance/level of competency. Spady and Schlebusch (1999:113), point out that "parents can be involved in continuous assessment by commenting on the work of their children in the portfolios". They further contend that "schools should send the portfolios home regularly and provide parents with opportunities to comment and take part in the learning process" (Spady & Schlebusch, 1999:114). Spady and Schlebusch (1999:114), further assert that "it is advisable to parents to set time aside to go through the portfolio in detail, to find aspects to comment on and admire and to listen to the child". They give the following example of how parents can make comments on their children's work (Spady & Schlebusch, 1999:115):

"I like your index page – it's neat and clear".

"I see you are really good at writing your own sentences now".

"Tell me what you like in this piece?"

"What would you do differently next time?"

Archer, Rossouw, Lomofsky, and Oliver (2004:118) make the following comment regarding the lack of proper participation by parents in learner assessment:

Parents are too often told, rather than asked, about their children's performance. Yet their opinions of their children are based on observations over the span of their child and on comparisons with the parents of other children. Arranging visitation by parents also give the educator information and better understanding of the home systems in which their learners function.

Some parents are illiterate and cannot be expected to write assessment comments. However, where the parent can read and write, the following procedure gives the idea of how parents can be involved in assessment:

- Send a learner's work at the end of a programme organiser;
- Ask the parent to discuss the programme organiser with the child, so that the child explains what the class did during the learning experience; and

- Let the parent complete the assessment form after having discussed the learning experience with the child.

2.5.5 Assessment Techniques

Assessment techniques refer to how learners generate evidence of performance. The list of assessment techniques is too long to describe, so suffice it to enumerate only a few. For physical science in the FET band, these techniques include, *inter alia*: Practical Investigations, Control Tests, Midyear examinations, Trial Examinations (grade 12 only), Research Projects and Final Examinations (Department of Education, 2007:9 –14)

2.5.5.1 Practical Investigations

According to the NCS Subject Assessment Guidelines for physical science, practical investigations and experiments should assess all learning outcomes, with the focus on the practical aspects of the curriculum and the process skills required for scientific enquiry and problem-solving. Assessment activities should be designed so that learners are assessed on their use of scientific enquiry skills. Such skills typically include planning, observing and gathering information, comprehending, synthesising, generalising, hypothesising and communicating results and conclusions. Practical investigations should assess performance at different levels across all the learning outcomes, with a greater focus on Learning Outcome 1 (Department of Education, 2005:10).

Science experiments are an example of formal curriculum-based problems. Criticos (2002:255), points out that “learners learn from experiments by observing the experiment (by modelling); actually experimenting (by practising); thinking about what they have observed and experienced (by reflecting); and relating all of this to their purpose: solving a problem (by applying)”. Educators may also use the Predict-Observe-Explain (POE) technique when engaging learners in science experiments where learners are taught to predict, observe and explain. The following are the advantages of using the Predict-Observe-Explain technique as a teaching strategy:

- Helps the teacher to be aware of what the learners already know (previous knowledge of learners);
- Promotes active participation of learners throughout the lesson;
- Encourages an accurate observation by learners when they compare their predictions with what they observed;
- Clears or corrects misconceptions from learners;
- Promotes trust between the teacher and the learner; and
- Promotes team work or team spirit among learners and some skills are acquired e.g. recording skill.

However, on the contrary, it is also argued that POE technique could promote pure guessing from learners if not carefully worded. A learner may be discouraged if at all time his/her predictions do not agree with his/her observations. This technique cannot suit all types of learners in class, for

example, in a class there may be learners with special educational needs. Therefore, educators should employ varied teaching strategies in class.

Experiments are an experiential form of teaching: learners learn by experiencing a process, observing the reactions, and talking about this experience. As with all problem-based teaching, experiments should involve learners in an activity, and the activity should be directed to solving a problem (or answering a problematic question). The activity generally tests a hunch, an idea, or a theory (called a hypothesis). The activity and findings of an experiment should reveal to learners certain basic rules about a concept (Criticos, 2002:257).

There are usually three parts to an experiment:

- Carrying out the experiment
- Recording the results, and
- Discussing the significance of these results.

Educators need to:

- Model (demonstrate) appropriate procedures;
 - Reinforce these procedures by getting learners to read in their textbooks and/or worksheets, to ascertain how and why they are doing the experiment;
 - Guide learners' actual doing – stop learners at critical stages
- (Criticos, 2002:257)

Hands-on activities are often used as adjuncts to, rather than an integral part of science instruction. While the activities themselves often engage students in a multi-sensory fashion, there is usually little or no attention given to how students interpret this diverse and stimulating information (Criticos, 2002:257). The Science Education, Vol.90, Nos.4-6, (2006:735) states that, "documents such as the National Research Council' Science Education Standards advocate that student should gain increasing sophistication in the actual practice of scientific exploration and reasoning, for example:

As a result of activities in grades 9 – 12, all students should:

- Develop abilities necessary to do scientific enquiry;
- Identify questions and concepts that guide scientific enquiry;
- Design and conduct scientific investigations
- Use technology and mathematics to improve investigations and communications;
- Formulate and revise scientific explanations and models using logic and evidence;
- Recognize and analyse alternative explanations and models; and
- Communicate and defend a scientific argument (NRC, 1996:173).

In the classroom envisioned by the frameworks, the reflective, inquisitive teacher with good understanding of the practice of science enquiry is necessary to the development of the reflective, inquisitive students (Minstrell & Van Zee, 2000). However, Jenkins (2007:728) states that “the teacher will require sophisticated knowledge as well as pedagogical skills if students are to explore fundamental issues about, for example, the interrelationship of observation and explanation while simultaneously striving to learn the relevant science”.

Practical investigation is one of the activities that form part of CASS for physical science in the FET band. In this regard, the practical investigation knowledge and pedagogical skills are a requirement for both physical science educators and learners.

2.5.5.2 Research Projects

According to the NCS Subject Assessment Guidelines for Physical Sciences, “A project in Physical Science is an extended task in which the learner is expected to select appropriate content to solve a context-based problem” (Department of Education, 2005:10). The guidelines further state that “a research project involves the collection of data and/or information to solve a problem or to understand a particular set of circumstances and/or phenomena” (Department of Education, 2007).

The projects are meant to involve a student, or group of students, working under the guidance and direction of a teacher. A project involves planning and developing a schedule of study and outcomes to be achieved over a period of time, usually longer than that of an individual assignment. Implicit in the project are educational ideas of deep learning as opposed to surface learning. The students are not only required to produce a single outcome, but are required to link multiple, and often distantly related, prior learning tasks. The role of the teacher, throughout the project, is one of a facilitator of each student's learning strategy (Starkings, 1997: 140).

It is important that both teachers and students know precisely what is involved in doing project work. The student should be familiar with the assessment structure that will be used by the teacher to assess and grade their project. Project work can be carried out individually or in groups. The formation of groups can be carried out in one of two ways: Either students form their own groups or the teacher works out the group membership (Starkings, 1997:140).

(a) Project Choice

Careful choice of a project is required, otherwise teachers may find that the project does not proceed very well, and in some cases not succeed at all. Whether students choose projects on their own or in conjunction with their teacher, clearly defined objectives for the project are essential. Teachers may vary in their opinion of projects. A great deal depends on whether projects

are introduced for examination purposes or for instructional reasons. If the projects are part of an examination syllabus, the assessment structure should be followed as stated in the syllabus. When projects are not part of a formal examination, an appropriate model for assessment should be worked out. These projects can be assessed in stages or at the end, depending on the teacher's preference and the nature of the work being done. (Starkings, 1997:139)

(b) Staged Assessment of a Project

Assessment can take many forms, for example, a project can be assessed at completion or may be assessed in stages. Different kinds of models may be used. A good motivation factor is to assess the project in stages, since this gives students feedback on their progress and induces them to continue with the work. The purpose of staged assessment (or assessment in stages) is to provide feedback for students at various points throughout the project. This enables the students to attain the maximum benefit and guidance throughout the project period (Starkings, 1997:142).

The two models described below, that is, the ADIE model (Analysis, Design, Implementation and Evaluation) and the 4P model (Project log, Project report, Practical development and Presentation), have marks allocated for the four stages. The ADIE model was designed to be used by individual students,

whereas the 4P model was originally designed for group projects (Starkings, 1997:142).

(i) The ADIE model

Each problem needs to be analysed first in order to design what data needs to be collected. A good project starts by analysing the problem and addressing the issues of interest or concern. Design of data collection and techniques to be used in data collection follows the analysis of the project problem. The statistical routines and methods are then carried out, with an evaluation of the whole process at the end. Hence each section could be graded separately, giving feedback to students in stages. If required, the project could be graded at completion, using this method. The ADIE model was developed by the Northern Examination Board (1988) and can be used with weightings given below. These allow for a maximum score of 40, but could be proportionally changed to be on a 0 – 100 scale. (Starkings, 1997: 143)

• **Analysis of the problem (Maximum 10 Marks)**

- Full, or near complete, logical breakdown	9,10
- Reasonably full, clear and well thought out breakdown	7,8
- Fairly clear thought out attempt	5,6
- Partially successful attempt	3,4
- Limited attempted	1,2

-	Not attempted	0
• Design (Maximum 8 Marks)		Marks
-	Accurate, detailed. Follows closely from analysis. Revised as, and if, necessary in light of other stages.	7,8
-	Reasonably accurate, detailed. Analysis considered. Some revision undertaken if needed.	5,6
-	Adequate attempt showing some links with analysis.	3,4
-	Some listing of resources	2
-	Limited attempt	1
-	Not attempted	0
• Implementation (Maximum 14 Marks)		Marks
-	Follows closely the design, uses appropriate techniques with skill and understanding to produce a good solution.	12,14
-	Mostly follows the design and appropriate techniques used with reasonable skill and understanding.	8,11
-	Some linking to design and techniques used with some understanding.	5,7
-	Techniques applied with some success	3,4
-	Some techniques undertaken	1,2
-	Not attempted	0

• Evaluation (Maximum 8 Marks)	Marks
- Clearly related solution to problem. Shows a good understanding and appreciation of the solution.	7,8
- Reasonably clear reference between the solution and the problem and some appreciation of the solution	5,6
- Some linking of solution to problem	3,4
- Mainly concerned with technical aspects	2
- Statement of what has been done	1
- Not attempted	0

Each stage above can be assessed and graded separately (Starkings, 1997: 144).

(ii) The 4P Model

The 4P model was developed at South Bank University (Elliot & Starkings, 1994) and is assessed in each of the four stages. Suggested weightings are: Project log 20%, Project Report 25%, Practical development 40% and Presentation 15%. The project log is addressed on an individual basis, thus allowing for individual members within a group to be assessed this way. The assessment takes into consideration the individual student's involvement in the group and his/her individual effort and contribution to the overall project. The mark is to be made on a continuous assessment basis, determined by

the supervising teacher during the project's time span. In making a judgement, the supervisor should refer to the content and accuracy of the student's individual logbook, which each group member keeps during the project lifetime. When grading the students' project log and the group-writing project, the following should be taken into account:

Project Log: (20%)

- (a) The individual student's effort and commitment.
- (b) The quality of work produced by the individual student.
- (c) The student integration and co-operation with the rest of the group.
- (d) The completeness of the logbook.

Project Written Report: (25%)

- (a) Introduction
- (b) Project specifications
- (c) Statistical techniques used and calculations
- (d) Solutions to the problem
- (e) Recommendations and conclusions

Practical Development: (40%)

- (a) The group's investigation of the practical aspect as evidenced in the report.
- (b) Integration of the practical development with the rest of the project.

- (c) The groups or individual's analysis and design of the problem.
- (d) The group's or individual's attempt at practical development.

Project Presentation: (15%)

- (a) General quality of the presentation.
- (b) Integration and teamwork.
- (c) Interest, content, and originality.
- (d) Use and quality of the statistics (Starkings, 1997:140 – 144).

2.5.6 Assessment Approaches

The assessment process includes a variety of approaches. Approaches to assessment actually refer to the main purpose of assessment. As described in the paragraphs below:

Base-line assessment is used by an educator at the beginning of a new set of learning activities in order to find out what the learner already knows and can demonstrate in order to decide what level of demands to build into the learning experience plan (Department of Education, 2001:14). Base-line assessment helps in the planning of activities and in learning programme development. The recording of base-line assessment is usually informal. According to Maree and Fraser (2004:49), this approach determines learner performance at the beginning of instruction to obtain an idea of the abilities and interests of the learners. They further state that

Assessment information such as test scores, observations of learner performance and learner involvement determines learner progress and level of understanding. Assessment that occurs prior to instruction is a valuable tool to facilitate instructional and planning activities, and also to direct subsequent assessments.

Diagnostic assessment is assessment, which specifically focuses on finding out the nature and cause of learning difficulties, in order to providing appropriate remedial help and guidance (OBE assessment, 2001:14). Any assessment can be used for diagnostic purpose to discover the cause or causes of a learning barrier. Diagnostic assessment assists in deciding on support strategies or identifying the need for professional help. It acts as a checkpoint to help redefine the learning programme goals, or discover what learning has not taken place so as to put appropriate intervention strategies in place. As Maree and Fraser (2004:49), state "the aim of diagnostic assessment is to determine causes of persistent learning problems and to formulate a plan for remedial actions".

Formative assessment is sometimes seen as being the opposite of summative assessment. It is conducted as the learning takes place and it is used to influence or inform the learning process.

Flanagan (1998:74), and Le Grange and Reddy, (1998:5), state that “any form of assessment that is used to give feedback to the learners is fulfilling a formative purpose”. Formative assessment is a crucial element of the teaching and learning process. It monitors and supports the learning process. All stakeholders use this type of assessment to acquire information on the progress of learners. Constructive feedback is a vital component of assessment for formative purpose (Department of Education, 2003:56). According to Maree and Fraser (2004:49), formative assessment monitors learning progress during instruction, and provides feedback to learners and educators concerning successes and failures.

Summative assessment refers to assessment that takes place at the end of the learning experience for a purpose outside the learning experience. One main test or examination that is written at the end of the school year usually constitutes it. The aim of the assessment is to determine how much of the subject's content the learners know. Sometimes a teacher is assessing a learner against some kind of norm or average performance of a particular section of the population or age group. Summative assessment provides information to other people, for example, parents and employers (Flanagan, 1998:74; Le Grange & Reddy, 1998:4). When assessment is used to record a judgement of the competence or performance of the learners, it serves a summative purpose. Summative gives a picture of a learner's competence or progress at any specific moment. It can occur at the end of a single learning

activity, a unit, cycle, term, semester or year of learning. Summative assessment should be planned and a variety of assessment instruments and strategies should be used to enable learners to demonstrate competence (Department of Education, 2003:56).

Summative assessment is almost always *norm-referenced*. This means that the learners' achievement is compared with that of other learners or with pass marks to determine how well the learner is doing. Norm-referenced assessment reflects little about what the learner has mastered or understood. For example, at the teacher-parent meeting held after the mid-year examination, James' parents are told that he attained 85 marks out of a possible 100 mark for a certain subject area. The teacher further explains that his performance is 15 marks better than the class average and 45 marks above the required pass mark. This leaves James' parents with a sense that he has "done well", compared with the other learners and the pass mark that were set, but they have very little understanding of James' competence in the subject area. (Flanagan, 1998:74; Le Grange & Reddy, 1998:4).

Dougherty (1997:33) differentiates between formative and summative assessment as follows:

The key difference between assessing summatively and assessing formatively resides in the application of the data the teacher collects. If the teacher uses those data to modify instructional practices in a way

that accommodates students' developmental positions and promote more learning, he or she is using assessment in a formative way.

Teaching is about what students *learn*, not what the teacher *presents*.

Dougherty (1997:33) further maintains that "if teachers make the commitment to help students learn science conceptually, teachers necessarily must change how they evaluate learning".

Criterion-referenced assessment refers' to testing in which learners' scores (results) are compared to a set standard. The scores are thus not compared to those of other learners or students, but to a given or set criterion or standard or performance. Criterion-referenced tests measure the mastery of every specific objective. It tells the teacher and the learner how well a task can be done. The results of a good criterion-referenced test should thus tell a teacher exactly what a learner can or cannot do; at least under certain conditions.

Assessment in the new system focuses on the learner's ability to perform a certain task against a fixed criterion which is a nationally agreed upon standard. The learner should know that his or her performance will be composed against the agreed upon standard only and not against the other learners in the class. The shift from a norm-referenced approach to a formative, criterion-referenced approach means that the focus will move from comparison to the assessment of an individual's performance against

predetermined criteria, that is, outcomes, or standards on the NQF. There is a shift from content measurement to performance assessment.

(Department of Education and Science and the Welsh Office, 1998:7).

Norm-referenced assessment indicates performance in terms of the relative position held in a specific group (e.g. to perform better than 90% per cent of the class members). Norm-referenced interpretations may relate to local, provincial or national groups, depending on the use to be made of the results. Norm-reference grading is based on comparing learners to one another. The function of each learner's grade is to indicate how the learner performed in comparison with other learners in a specific grouping (Maree & Fraser, 2004:51).

A *performance assessment* is a direct and systematic observation of an actual learner performance or examination products created. During a performance assessment, learners are engaged in activities that require the demonstration of specific products. The demonstration can take place in a controlled environment (such as a laboratory or classroom) or in a real-life environment where the complexities faced by the learners are much higher. In the latter case, the performance assessment is also called "authentic assessment". In both cases, the learner can demonstrate complex learning that integrates knowledge, skills and dispositions or attitudes in a single performance. (Master & Forster, 1996:25).

2.5.7 Methods of Collecting Assessment Evidence

There are various methods of collecting evidence. Some of them are discussed below:

Observation-based assessment methods tend to be less structured and allow the development of a record of different kinds of evidence for different learners at different times. This kind of assessment is often based on tasks that require learners to interact with one another in pursuit of a common solution or product. Within the context of the NCS, observation has to be intentional and should be conducted with the help of an appropriate observation instrument (Department of education, 2003:58).

Test-based assessment is more structured, and enables teachers to gather the same evidence for all learners in the same way and at the same time. This kind of assessment creates evidence of learning that is verified by a specific score. If used correctly, tests and examinations are an important part of the curriculum because they give good evidence of what has been learned. (Department of Education, 2003:58, 59)

Task-based methods aim to show whether learners can apply the skills and knowledge they have learned in unfamiliar contexts outside of the classroom. Performance assessment also covers the practical components of the subjects by determining how learners put theory into practice. The criteria,

standards, or rules by which the task will be assessed are described in rubrics or task checklists, and help the teacher to use professional judgement to assess each learner's performance (Department of Education, 2003:59).

2.5.8 Assessment Tools

According to the Department of Education (2001:30) assessment tools are the records of CASS that the educator keeps. They include, *inter alia*, observation sheets, journals and learning logs, assessment rubrics/grids, class lists, profiles and rating scales. These tools are described in the forthcoming sections.

2.5.8.1 Rating Scales

According to the Department of Education (2003:59) rating scales are any marking system where a symbol (such as A or B) or a mark (such as 5/10 or 50 %) is defined in detail to link the coded score to a description of the competences that are required to achieve that score. The detail is more important than the coded score in the process of teaching and learning, as it gives learners a much clearer idea of what has been achieved and where and why the learner has fallen short of the target. A six-point scale of achievement is used in the National Curriculum Statement Grades 10 – 12 (General).

Airasian (2005:250) sees rating scales as the assessment tools that allow the educator to judge the performance of learners along a continuum rather than a dichotomy. Both checklists and rating scales are based on a set of performance criteria, and it is common for the same set of performance criteria to be used in both rating scales and checklists. However, a checklist gives the educator two categories for judging, while rating scales give more than two.

Three of the most common types of rating scales are the numerical, graphics and descriptive scales. In numerical scales, a number stands for a point on the rating scale. For example, "1" stands for always, "2" stands for usually, and so on. In graphics scales, the educator marks an 'X' at the point which describes the learner's performance. Descriptive rating scales are also called scoring rubrics (Airasian, 2005:250).

2.5.8.2 Assessment Rubrics or Grids

Rubrics are defined as "scoring tools that list the criteria according to which a particular task will be assessed or list of criteria for marking" (Department of Education, 2005:20). A rubric can also be defined as a set of criteria that is used to ensure that different parts of the task are assessed. It is a handy tool for gathering information. Rubrics are used to determine the level of performance of the learner or group in a particular task; they tend to make

assessment more objective. Learners need to know what assessment instruments are being used and outcome or performance being assessed.

Rubrics are rating scales – as opposed to checklists – that are used with performance assessment. Rubrics require educators to know exactly what is required by the outcome. They are formally defined as scoring guides, consisting of specific pre-established performance criteria, used in evaluating student work on performance assessment. Rubrics are typically the specific form of scoring instrument used when evaluating student performances or products resulting from a performance task.

According to the (Department of Education, 2005:20), there are two types of rubrics, that is, holistic and analytic rubrics:

A holistic rubric requires the teacher to score the overall process or product as a whole, without judging the component parts separately. An holistic rubric gives a global picture of the standard required, and are utilised when errors in some part of the process can be tolerated, provided the overall quality is high. The use of holistic rubrics is more appropriate when performance tasks require students to create some sort of response and where there is no definitive correct answer. The focus of a score reported using a holistic rubric is on the overall quality, proficiency, or understanding of the specific content and skill. It includes assessment on a unidimensional level. Holistic rubrics are also

used when the purpose of the performance assessment is summative in nature. At most, only limited feedback is provided to the student as a result of scoring performance tasks in this manner.

In an *analytic rubric*, in contrast to the holistic rubric, the teacher scores separate, individual parts of the product or performance first, then sums the individual scores to obtain a total score. An analytic rubric gives a clear picture of the distinct features that make up the criteria, or can combine both.

According to the Department of Education (2003:60)

Analytic rubrics are usually preferred when a fairly focused type of response is required; that is, for performance tasks in which there may be one or two acceptable responses and creativity is not an essential feature of the students' responses. Furthermore, analytic rubrics result initially in several scores, followed by a summed total score. Their use represents assessment on a multi-dimensional level. The advantage of the use of analytic rubrics is quite substantial. The degree of feedback offered to students and to teachers is significant. Students receive specific feedback on their performance with respect to each of the individual scoring criteria – something that does not happen when using holistic rubrics. It is possible to then create a "profile" of specific student strengths and weaknesses.

2.5.8.3 Observation sheet / Task Lists or Checklists

According to the Department of Education (1993:106-108) an observation sheet or checklist is a tool which an educator uses to monitor specific skills, behaviours or dispositions of individual learners or all of the learners in his class. It is also a record keeping device for educators to use to keep track of who has mastered the targeted skills and who still needs help. The specific skills, behaviours and achievements must be linked to the learning programme outcomes and be readily observable.

Tasks lists or checklists consist of discrete statements describing the expected performance in a particular task. When a particular statement (criterion) on the checklist can be observed as having been satisfied by a learner during a performance, the statement is ticked off. All statements that have been ticked off on the list (as criteria that have been met) describe the learner's performance. These checklists are very useful in peer or group assessment activities (Department of education, 2003:60).

2.5.8.4 Portfolios

CASS is school-based and consists of practical work, written tasks, tests, research projects, and any other task peculiar to that learning area or subject. This formal form of assessment used in schools should cover a full range of skills, knowledge, attitudes and values (SKVA). In the teaching and learning

experience, the evidence of this assessment is collected into a portfolio (Ngidi, 2006:60).

Frazer and Maree (2004:149) and Airasian (2005:264) define a portfolio as “purposeful collection of learners’ work that exhibits the learners’ efforts, progress and achievements in one or more areas”. The collection must include learner participation in selecting contents, the criteria for selection and the criteria for judging merit and evidence of student self reflection.

Airasian (2005:264) states that portfolios contribute to instruction and learning in the following ways:

- Showing learners’ typical work;
- Monitoring learners’ progress and improvement over time;
- Providing ongoing assessment of learner performance;
- Helping educators judge the appropriateness of the curriculum;
- Facilitating educator meetings and conferences with learners, parents, and both learners and parents;
- Grading learners;
- Reinforcing the importance of processes and products in learning;
- Showing learners the connections among their processes and products;
- Providing concrete examples of learners’ work;

- Encouraging learners to think about what is good performance in varied subject areas;
- Focusing on both the process and final product of learning; and
- Informing subsequent educators about learners' work.

Airasian (2005:265) is of the view that "whatever a portfolio's use and content, it is important that it has a defined, specific purpose that will focus on the nature of the information that will be collected in the portfolio". Collecting pieces of learners' work in the portfolio retains them for subsequent learner review, reflection, demonstration and grading. According to Le Grange and Reddy, 1998:23), "it is important to determine the purpose and guidelines for a portfolio's content before compiling it". Archer *et al.* (2004:20) concur with this view, and observe as follows:

A portfolio gives a tangible evidence or demonstration of the learners' progression and development to parents, other educators, principal and the governing body, also provides the basis for interviews and discussions with individual learners.

Portfolios can be divided into two, namely, learners' portfolio and educator's portfolio.

2.5.8.4.1 Learner's Portfolio

Archer *et al.* (2004:120), observe that a learner's portfolio could be a file, a container, or a box, a drawer in a cabinet, a binder or a cover which houses especially selected collection of a learner's work such as writings, drawings

crafts, maps, reports, audio and video tapes, journal entries, and other assessments. It may contain anything which an educator or a learner regards as having value for assessment purposes. A learner's exercise books is also part of a portfolio.

2.5.8.4.2 Educator's Portfolio

An educator's portfolio is a compilation of the entire tasks of school-based assessment as well as corresponding assessment instruments. An educator's portfolio is required for every learning area or subject. The purpose of the educator's portfolio is to ensure the quality of the assessment tasks given to the learners and provide a record against which a learner's portfolio can be moderated (Department of Education, 2002:30).

A variety of assessment tools have been explored. In the NCS curriculum, these assessment tools are essential since they provide evidence that assessment was done. Thus, physical science educators should be well versed about these for the successful implementation of the NCS.

2.6 PROFESSIONAL DEVELOPMENT

Jones, Clark, Figg, and Howard (1989:5) "define education as a process, not a once-off occurrence. Teachers are in service from their first day on contract to the time they retire". They further state that "during this period they will experience a variety of forces which will produce change in knowledge,

understanding, skills and probably, attitude. Without this change, 'schooling', as opposed to education, will stagnate" (Jones, Clark, Figg & Howard, 1989:5).

A number of related concepts are used to describe professional development in education as is evident from the numerous terms found in the literature (Webb, Montello & Norton, 1994:234). Such terms include "in-service training", "professional growth", "personal development", "on-the-job training" and personnel "training".

According to O'Neill (1994:285), and within the context of education, "professional development describes an ongoing development programme which focuses on a wide range of knowledge, skills and attitudes required to educate learners effectively". It is further described as a "formal systematic programme designed to promote personal and professional growth" (Steyn, 2001:44). Professional development therefore "refers to the participation of teachers in development opportunities in order to be better equipped as teachers and as leaders" (Schreuder, Du Toit, Roesch & Shah, 1993:1).

The purpose of professional development is determined by the background and circumstances. However, the following could be regarded as the purpose of professional development (Tjepkema & Wognum, 1992:251):

“Personal development: advancing educator’s knowledge and skills for personal and professional use. *Career development:* supporting the professional advancement of educators to jobs at higher level in the school by providing them with the necessary qualifications and developing the skills of important selected staff members so that anticipated vacancies can be filled. *Organizational development:* improving performance to benefit the whole school can benefit and serve the primary aims of education system, that is, the promotion and attainment of quality teaching and learning”

The goal of teaching new skills and knowledge is to make it possible for educators to improve their performance (Tjepkema & Wognum, 1992: 249). However, new qualifications do not necessarily lead to improved performance. For example, a teacher cannot apply newly learned skills if the school does not have adequate equipment, such as science kits, computers and laboratories. Poor performance may also not have been caused by a lack of knowledge and skills in the first place, but by, say, a lack of time to perform the task adequately. Professional development can be planned from two perspectives, that is, on correcting professional shortcomings and on creating opportunities for development (Schreuder et al, 1993:1).

Tjepkema & Wognum (1999:249), further argue that “the purpose of professional development is therefore to promote learning processes which

will in turn enhance the performance of individual science educator and the school as whole". In addition, they assert that "acquiring new knowledge and skills is not a goal in itself; it is a means to achieving performance improvement and/ or school development".

Morrison (1998:89) provides the following list as focus areas for educator training:

- Subject knowledge
- Subject application
- Planning the curriculum
- Class management
- Pupil learning
- Teaching strategies and techniques
- Assessment and recording of pupils progress
- Further professional development
- Relationships with children
- Pastoral care
- Departmental management
- Leadership

The South African Council for Educators (SACE) and the Department of Education (DoE) (2008:1) make the following comment regarding continuing professional teacher development:

Continuing Professional Teacher Development (CPTD) is a vehicle for socio-economic development in any country including South Africa. Of most importance is the fact that continuing professional teacher development is the most integral aspect of the overall human resource development of the country. This is particularly so in today's global competition in education that calls for educators to confront the broad pressures that now shape our children's future, and which subsequently place greater demands in the workplace. Poorly educated citizens give rise to social and economic challenges including rising unemployment, poverty, social ills such as crime, the HIV/AIDS pandemic, drug abuse and rape to mention a few.

The basic professional development activities for the new curriculum are content knowledge, portfolios, reading strategies and assessment. The South African Council for Educators and the Department of Education (2008:1) further stated that "professional development activities must be of quality and relevant to teachers' needs" (SACE & DoE, 2008:2). SACE and DoE (2008) maintain that effective professional teacher development programmes should begin with an understanding of teachers' needs and their work environment (schools and classrooms) and then enhanced by an effective and fair

Integrated Quality Management System (IQMS). The scope of the professional development activities should address teachers' professional growth plans that arise out of their needs. Therefore, it can be said that a thorough needs analysis must be done around the issue of the quality of professional development programmes.

Loucks-Horseley, Hewson, Nove and Stills (1998) claim that most science teachers think of professional development as in-service workshops. They further claim that indeed, workshops can be helpful learning experiences, yet they are often poorly designed, inadequately addressing the needs of participants. Further, they maintain that there are numerous other ways, often neglected, in which teachers can learn both science content and effective teaching strategies. From the above claims, it is clear that a good needs analysis exercise is an essential precursor to professional development for teachers.

The National Research Council (1996) enumerates four professional development standards to be met by teachers of science in the following ways: Firstly, "professional development for teachers of science requires learning essential science content through the perspectives and methods of inquiry" (National Research Council, 1996:59). Loucks-Horseley, *et. al* (1998) also maintain that the standards place a high value on teachers' participation in scientific enquiry in order to understand it as the process

through which scientific knowledge is produced, as abilities that students need to acquire, and as a way of learning and teaching science.

Secondly, “professional development for teachers of science requires integrating knowledge of science, learning, pedagogy, and students; it also requires applying that knowledge to science teaching” (National Research Council, 1996:62). This means that effective teachers are those who understand how students learn important scientific concepts, what concepts students are capable of understanding at different stages of development, and what experiences, examples, and representations help students learn. Loucks-Horseley *et. al* (1998) also maintain that this specialized knowledge that excellent teachers have, which is labelled “pedagogical content knowledge”, needs to be the focus of professional development.

Thirdly, “professional development for teachers of science requires building understanding and ability for life long learning” (National Research Council, 1996:68). Good teachers know that by choosing the teaching profession they have committed themselves to lifelong learning. In this regard, Loucks-Horseley, *et. al* (1998) make the observation that the National Science Education Standards acknowledge that new knowledge is always being produced, so teachers need ongoing opportunities to learn. Educators need to learn from their own practice and from their colleagues. Thus, professional development must help teachers acquire the skills to learn in many ways

through scientific enquiry, self- and peer-observation, and consultation with various sources of information available both in print and telecommunications. Educators must be committed to applying their learning to their teaching practice.

Fourthly, the National Research Council (1996:70) posits that “professional programmes for teachers of science must be coherent and integrated”. This is intended to counter the tendency of having fragmented and discontinuous professional development opportunities. They are often too short, not linked to teachers’ classroom and curricula, infrequent, and lacking in ongoing support. Staff development must be rigorous and intensive because short, one-credit workshops are not sufficient to bring about significant change.

According to the National Research Council (1996:55), “teachers of science are professionals responsible for their own professional development and for the maintenance of the teaching profession”. The Council further states that “becoming an effective science teacher is a continuous process that stretches from pre-service experiences in undergraduate years to the end of a professional career” (National Research Council, 1996:55). Radford (1997:48) argues that “professional development for teachers of science requires learning essential science content through the perspectives and the methods of inquiry...” integrating knowledge of science, learning, pedagogy, and students; it also requires applying that knowledge of science teaching”.

In the same view, Hargreaves and Fullan (1992:2) state that “one way of providing teachers with ‘opportunities to teach’ is to equip them with the knowledge and skills that will increase their ability to provide improved opportunities to learn for all their pupils”. Morant (1989:1) also observes that professional development starting point thus “should be marked by the occasion when the newly qualified entrant to the teaching profession takes up his first appointment in school. Its finishing point coincides with retirement”

Howey (1985:59) identified six general purposes of staff development, as follows:

- Continuing pedagogical development;
- Continuing understanding and discovery of self;
- Continuing cognitive development;
- Continuing theoretical development;
- Continuing professional development; and
- Continuing career development.

Deng (2007:503) asserts that “what teachers need to know about the subject matter they are supposed to teach is an important issue in teacher preparation, certification, and professional development”. As such, it is crucial for constructing curriculum materials that can be a resource for teacher learning (Ball & Cohen, 1996; Collopy, 2003; Davis & Krajcik, 2004, 2005).

Furthermore, to help physical science educators do outcomes-based assessment properly, "it matters for designing and developing pre-service and in-service teacher education programmes (Ball, et al. 2001; Grossman, 1990; Kennedy, 1990; Shulman, 1987). By way of definition and conceptualisation, according to Shulman (1986:9), content knowledge refers to "the amount and organization of knowledge *per se* in the mind of the teacher". Shulman (1986) advanced thinking about teacher knowledge by introducing the idea of pedagogical content knowledge (PCK). He claimed that "the emphases on teachers' subject knowledge and pedagogy were being treated as mutually exclusive domains" (Shulman, 1987:6). Pedagogical content knowledge was then defined as:

That special amalgam of content and pedagogy that is uniquely the providence of teachers, their own special form of professional understanding...Pedagogical content knowledge... identifies the distinctive bodies of knowledge for teaching. It represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to diverse interests and abilities of learners, and presented for instruction. Pedagogical content knowledge is the category most likely to distinguish the understanding of the content specialist from that of the pedagogue (Shulman, 1987:8).

To characterise the complex ways in which teachers think about how particular content should be taught, he argued for pedagogical content

knowledge as the content knowledge that deals with the teaching process, including “the ways of representing and formulating the subject that make it comprehensible to others” (Shulman, 1986:9). PCK exists at the intersection of content and pedagogy. Content knowledge was later on further articulated by Grossman, et al. (1989) as consisting of the following four components:

- Content knowledge – the ‘stuff’ of a discipline;
- Substantive knowledge – knowledge of the explanatory framework or paradigms of a discipline;
- Syntactic knowledge – knowledge of the ways in which new knowledge is generated in a discipline; and
- Beliefs about the subject matter – feelings and orientations toward the subject matter.

In Shulman’s theoretical framework, teachers need to master two types of knowledge: (a) content, also known as “deep” knowledge of the subject itself, and (b) knowledge of the curricular development (Shulman, 1992). At the heart of PCK is the manner in which subject matter is transformed for teaching. This occurs when the teacher interprets the subject matter, finding ways to represent it and make it accessible to learners.

In addition to the above points it is further said that “knowing the subject matter of a secondary-school science subject entails an understanding of how the concepts and principles to be taught can be formulated on the

psychological plane, concerning how they can be developed out of the interest, experience and prior knowledge of students" (Deng, 2007:522). In the words of Dewey (1990:208), "the teacher needs to know how to 'psychologize' a particular concept or principle; that is, 'to take it and to develop it within the range and scope of the child's life' ". In other words , the teacher helps students formulate the concepts through evoking various examples or instances from their daily experiences (Deng, 2007:522). In many situations students already possess experience and knowledge that can be used as productive resources for learning a particular scientific concept or principle (Hammer & Elby, 2003). However, in other situations students might have knowledge and experience (e.g. alternative concepts and principles) that are counterproductive to the learning of particular scientific concepts and principles. They may find learning a particular concept or principle extremely difficult because of its contradiction with their existing knowledge and experience. In these situations teachers might find it useful to expose and challenge students' experience and ways of reasoning with examples, questions, and models that are within the realm of their experience and knowledge background (Deng, 2007:523). Ball, Lubienski and Mewborn (2001:448), make a similar point when arguing that knowing school mathematics requires "a unique understanding that intertwines aspects of teaching and learning with the content".

According to the Education White Paper 6, it is required that

All curriculum development, assessment and instructional development programmes make special efforts to address the learning and teaching requirements of diverse range of learning needs that they address barriers to learning that arise from language and the medium of learning and instruction; teaching style and pace; time frames for the completion of the curricula; learning support material and equipment; and assessment methods and techniques (Department of Education, 2001:49).

The Department of Education further states that

district support teams and institutional level support teams are required to provide curriculum, assessment and instructional support in the form of illustrative learning programmes, learner support materials and equipment, assessment instruments and professional support for educator, at special schools/resource centres and other educational institutions (Department of Education, 2001:49).

It was the concern of the former Minister of Arts, Culture Science and Technology (Science and Technology Calender, 1998:4) that “many of our young scholars fear that science and the language that it uses, mathematics, are ‘difficult’, and hence should be avoided”. Science and Technology Calender further states that

It was therefore the perception of the said former minister that it does not take a great sage to predict that the welfare of every country in the shrinking global village will depend increasingly on the mastery and application of technology, which in turn depend on the quality of science which it practices.

He further maintained that the Department of Arts, Culture, Science and Technology "must ensure that the quality of teaching in our country measures up to the need to make our young literate in science and technology". The teaching and learning of physical science should build up learners' "confidence so that they will apply their talents in these fields as their counterparts do in other countries of the world" (Science and Technology Calendar, 1998:4). Therefore, it might be said that "ongoing professional development is essential if learners are to be given quality education" (Louw, 1992:1). It implies the continuous growth of physical science educators.

A common key goal of professional development involves improving student learning through change in teacher practice, primarily through enquiry-based instruction. Research on teacher change (Ball & Cohen, 1999) suggests that beliefs only change once teachers observe the beneficial effect on their students. However, Garet, et al (2001) suggests that changes in practice occur after new knowledge and skills are acquired.

The South African government's new NCS for grades 10 to 12 (Department of Education, 2003), in line with its earlier White Paper on Science and Technology (Department of Arts, Culture, Science and Technology, 1996), makes it clear that adequate skills and knowledge of mathematics and physical / life science are believed to be vital components of successful contemporary life and socio-economic development. Furthermore, it is said "among the many factors that influence achievement in mathematics and natural sciences, the role of teachers' pedagogical knowledge and skills in their subject area are all acknowledged to be key factors. Teachers' craft knowledge - that is, knowledge and beliefs regarding pedagogy, students, subject matter and curriculum (Van Driel, Verloop & De Vos, 1998) - is related to teacher effectiveness (Darling-Hammond, 2000; Hill, Rowan & Ball, 2005). Moreover, there is overriding evidence that teacher quality in terms of teacher preparation and qualification strongly influence students' level of achievement (Darling-Hammond, 2000; Darling-Hammond, Berry & Thoreson, 2001; Goldhaber & Brewer, 2000). However, it is widely recognized that, for historical reasons, the training of mathematics, physical science, and biology teachers in rural areas is of variable, but largely inadequate, quality (Arnott, Kubeka, Rice & Hall, 1997; Mailula, 1995; Ngoepe, 1995).

Physical science educators can also be developed professionally through mentoring. According to Butler (1998:90), "mentoring happens when more experienced educators help their less experienced peers". The SMT should

assign a mentor or friend to each new educator. Butler (1998: 90) further maintains,

Ideally, the mentor should be a sympathetic person who teaches either, in the same grade, or the same learning area as the new teacher". He further suggest that "it is better if the mentor is a successful educator and not too much older than the beginner (Butler, 1998:90).

All too often "school improvement efforts focus on new programmes and procedures that will transform a school. The new curriculum materials and approaches such as RNCS and new methods of student assessment and reporting student achievement are examples of significant school improvement efforts" (DuFour & Berkey, 1995: 2). However, "unfortunately these efforts cannot be regarded as a panacea (solution or cure) for complex problems. It is important to realise that it is not the programmes and materials that bring about effective change, but the people in the education system", that is, science educators in this case (DuFour & Berkey, 1992:2).

Focusing on people (educators) in the organization is the key to quality and effective improvement in schools and organizations. Finding fresh and inventive methods for professional training remains a problem for education managers (Bunting, 1997:30). Professional development seminars, workshops and coaching may be helpful, but the changing demands and circumstances in schools and in the country have created an urgent need to approach educators' professional development differently.

Laugksch, Rakumako, Manyelo and Maybe (2005:273 –278) state that “the effectiveness and the success of INSET programmes in general depend on at least two factors. First, efficient and effective planning of INSET activities on the provincial level requires that planners have at their disposal accurate demographic information of relevant subject teachers in the province. The second factor is the need for such activities to address expressly the perceived INSET needs of teachers (Zerub & Rubba, 1993). Dunlap (1995:156), also points out that “before planning begins a thorough needs analysis is required”. Castetter (1996:236) further suggests that “these needs have to be determined at three levels: individual, group and school”. Some needs are specific to an individual, although two or more individuals may have the same need; other needs concern groups of people or even the entire school or organization. Lubben (1994) argues that INSET activities are usually structured on the basis of the observations of INSET providers and the requests of the educational administrators, without consulting teachers to identify their priority needs. When teachers are not consulted about their work environment, and planners assume that they know what is best for teachers, teacher morale suffers, INSET programmes are poorly attended, and achievement is scarcely influenced (Mecca & Klindienst, cited by Baired & Rowsey, 1989). This view is supported by Cushway (1994:99) who avers that “professional development programmes require an intensive systematic analysis of needs so that areas for professional development can be selected

and planned for". He further states that "in this way the development (training) gap between actual staff performance and desired staff performance can be identified".

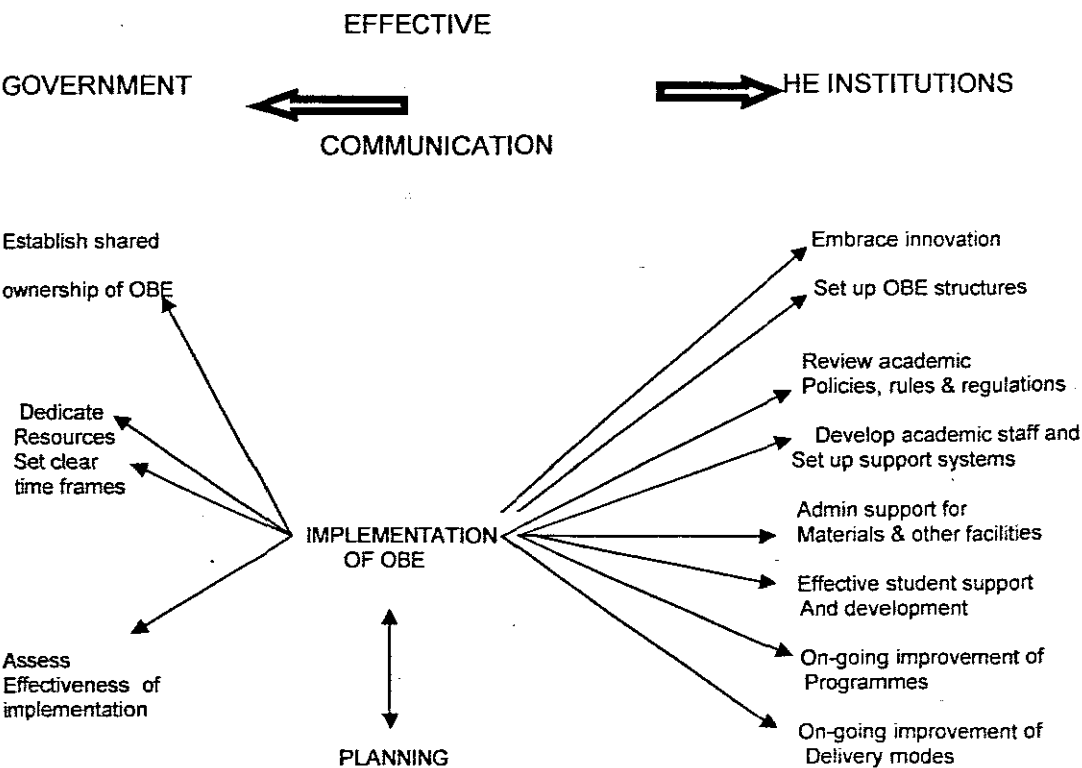
Involving teachers in helping to determine their individual development or training needs can enhance the success and effectiveness of the professional development progress. Indeed, Baired, Easterday, Rowsey and Smith (1993) maintain that INSET programmes based on the expressed needs of teachers yield more positive responses. Smith and Haley (cited by Easterday & Smith, 1992) add that such programmes can also boost workshop attendance rather than programmes which are not applicable to teachers' classroom needs.

Professional development should meet the needs of both the individual educator and the education system. This means that "the unique characters of teachers should be acknowledged and accommodated" (Steyn, 2001:48). In the same vein, it is the view of Jonston (1995:46), that "all staff should have some degree of ownership of professional development programmes". One way of achieving this is to establish a school professional development committee. The empowerment of individual teacher is the key to quality improvement and, therefore, newly learned skills should be supported by adequate equipment.

2.7 MODEL FOR SUCCESSFUL IMPLEMENTATION OF OBE

Imenda (2002:33) in his inaugural lecture at the erstwhile Technikon Pretoria suggested a model for the successful implementation of OBE in South Africa. According to his model, successful implementation will only occur where there are effective joint actions between government (Ministry of Education) and individual Higher Education (HE) institutions, where the actual implementation takes place (Imenda, 2002:33). Figure 2.1 below is a model that was suggested:

Figure 2.1 A model for effective implementation of OBE in South Africa



In adapting the above model for the FET band, a much simpler model emerges. This is shown in Figure 2.2. Thus, Figure 2.2 below is a conceptual framework for the successful implementation of the NCS.

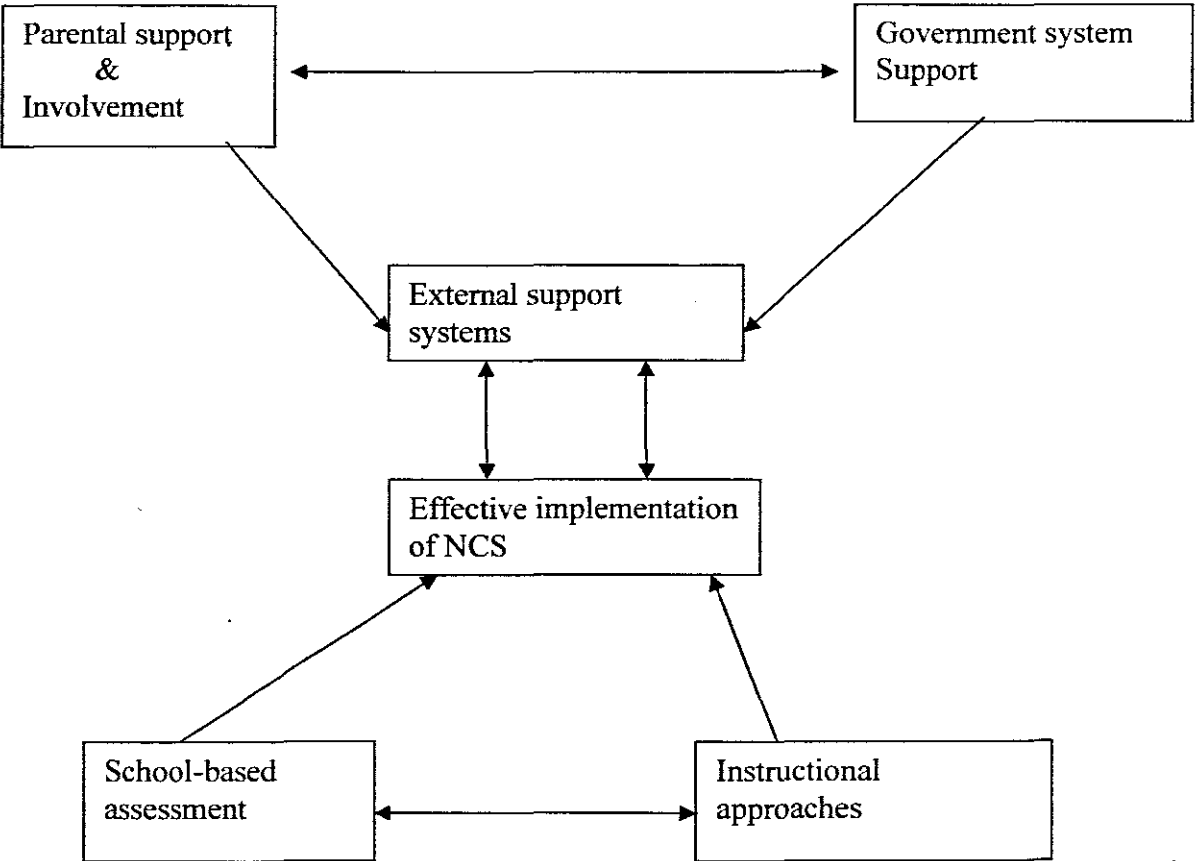


Figure 2.2 Conceptual Framework for the successful and effective implementation of the NCS.

According to Figure 2.2, the successful implementation of the NCS will occur where there are effective joint efforts by the government, schools and family structures (parental support and involvement). The suggested model in Figure 2.1 lacks the element of parental support. In response to parental involvement in education, some changes in the field of education have taken place (Madondo, 2002:7). At the heart of these changes is the South African Schools Act No.84 of 1996, (Government Gazzette, 1996) which amongst others, grants a greater say to parents. In term of this Act parents have a very important role to play in education. They are required to share the responsibility of education of their children with the State. This model (Figure 2.2) not only summarises the literature reviewed in this chapter, but also directed the rest of the study by serving as the conceptual framework for it.

2.8 CONCLUSION

In this chapter, a number of conceptual, theoretical areas have been reviewed in connection with outcomes-based education, generally, and also more specifically in relation to the FET band. The focus was mainly on physical science as a learning field subject. The following were the main themes that were discussed: parental support and involvement; professional development; enabling facilities, resources and professional support; instructional strategies appropriate for use by science educators and the range of assessment strategies which could be used by science educators. The latter also included assessment methods, tools and techniques, as well as involvement of

industry or business as partner in education. The literature review culminated in a conceptual model to harmonise all the major aspects covered, and serve as a basis for the subsequent context of the study. The next chapter deals with research methodology.

CHAPTER THREE

RESEARCH METHODS

3.1 INTRODUCTION

This chapter follows on chapter two which dealt with the theoretical framework and review of literature. Some theoretical ideas about OBE, outcomes-based assessment and learning theories were discussed. Accordingly, the theoretical framework and the review of literature laid the foundation for exploring the problem further through the use of data collection instruments described in this chapter. Through the use of questionnaires, questions were asked in order to provide the necessary answers to the research questions of this study. This chapter focuses on the research design and methods used in data collection, the description of the population and sample, as well as instrumentation.

3.2 THE RESEARCH QUESTIONS RE-STATED

The principal objective of this study was to find answers to the following research questions:

- What role do parents play as a way of supporting their children in the implementation of the NCS new curriculum?
- What instructional strategies do physical science educators use in their adaptation to the new curriculum, particularly in lieu of the necessary laboratory facilities and other resources?
- What assessment strategies, processes and procedures do physical science educators commonly use in the implementation of NCS?

- What are the professional development needs of physical science educators for the effective implementation of the NCS?

3.3 RESEARCH DESIGN

Schumacher and McMillan (1993:31) refer to research design as the plan and structure of the investigation used to obtain evidence to answer research questions. A research design is therefore, the consideration and creation of means of obtaining reliable, honest, transferable and valid data, by means of which pronouncements about the phenomenon being investigated may be confirmed or rejected. This is also the view of MacKendrick (1987:256) who states that research design is an overall plan or strategy by which questions are answered where a hypothesis is tested.

This study is located largely within both the qualitative and quantitative research paradigms. It takes the form of a case study involving eleven selected schools drawn from Empangeni District. According to Cohen and Manion, (1990) a case study is a technique the researcher uses to observe characteristics of an individual unit, for example, a child, school or community. Best and Kahn, (1989) define a case study as a way of organizing social data for the purpose of viewing social reality. To Yin (1983:22) a case study is an enquiry that investigates a contemporary phenomenon in which multiple sources are used. Thus, this study examined the implementation of the physical science curriculum in terms of the research questions re-stated above.

In this study the focus was on challenges facing physical science educators in the implementation of the NCS. A sample comprising seven high schools (five urban high schools and two rural high schools) was studied. The seven schools were selected using stratified random sampling (Strydom, 2005:202; Uys & Puttergill, 2005:113). From the seven schools selected, only physical science educators teaching grades 10 – 12 participated in the study, together with the physical science learners doing the same grades.

The decision to do a case study by limiting the scope of the investigation to seven schools in Empangeni Education District was based on Babbie's view that a profound study of a particular case can generate explanatory insights (2004:293). Leedy and Ormrod (2005:135) also hold the view that small case studies are particularly valuable for generating or offering initial support for hypotheses. The researcher is thus of the opinion that, although small in scale, the investigation will be particularly significant in that it will reveal aspects common to many other similar settings.

This research study can be placed within the pragmatic paradigm, as both qualitative and quantitative methods were combined (Morgan, 2007:72). In order to determine the challenges facing physical science educators in the implementation of the NCS at these seven high schools, questionnaires were administered to physical science educators and physical science learners

doing grades 10 – 12. The questions that were asked aimed to obtain quantitative data (the educators qualifications, experience in teaching physical science in grades 10 – 12, workshops attended, instructional and assessment strategies they used) as well as qualitative data (the parents' attitudes to education and their involvement in school activities).

3.4 MEANING OF RESEARCH

Francis (1994, 2-3) defines research as a careful enquiry of a topic of interest to discover new information or relationships and to expand and to verify existing knowledge. Francis continues to assert that research is the *manipulation of things, concepts, or symbols for the purpose of generalizing and extending, correcting or verifying knowledge, whether that construction aids in the construction of a theory or in the practice of an art.* In this regard, research includes all the activities like collecting data, conducting tests, developing standards and maintaining statistics on a given issue. Research further attempts to formulate scientific generalizations that may be applied to a variety of problems. Hence, in general, research is a relatively long, specialized and thorough ongoing investigation of a properly selected topic. It includes analysis of collected data in a logical way in order to achieve a specific research goal. This is the approach followed in this research.

Research is a systematic, objective and accurate search for the solution to a well-defined problem. Monly explains that in order to draw or state

conclusions, there should be a systematic application of the scientific research method; there should be an overall strategy that is followed in collecting, interpreting and analyzing data, which is orientated towards the development of theories or arriving at dependable solutions to problems. Research is the most important tool for advancing knowledge, developing progress and resolving conflict. With all the changes this research is therefore the primary tool used to understand and evaluate the OBE approach as a new instructional strategy in the FET institutions with special reference to how it is implemented in under-resourced schools.

3.5 THE RESEARCH SAMPLE

The research sample for this study consisted of 16 physical science educators and 320 physical science learners drawn from seven (7) schools from Empangeni District. The research was conducted in the selected schools in the Empangeni District. There are seventy three (73) high schools in the Empangeni District. The composition of the sample was as follows: there were five urban area high schools from which three were ex-Model C schools and two high schools were located in remote rural areas. Two of these schools were located in the townships. Stratified random sampling was used. The respondents were regarded as key informants. Walcott (1988:195) defines key informant as an individual "in whom one invests a disproportionate amount of time because that individual appears to be particularly well informed, articulate, approachable, or available and resourced".

The schools that were selected were varied in their structure. Amongst the schools selected, three (3) of them were former Model C schools which were thought to have more facilities and resources than township and rural schools. There were two (2) township schools and also two (2) rural schools.

Table 3.1 presents the schools that were selected for participation in the study.

Table 3.1 Schools randomly selected

NAME OF SCHOOL	SITUATION / LOCATION
SCHOOL A	Urban Area School (ex-Model C)
SCHOOL B	Urban Area School (ex-Model C)
SCHOOL C	Urban Area School (In Township)
SCHOOL D	Urban Area School (In Town)
SCHOOL E	Urban Area School (ex-Model C)
SCHOOL F	Rural Area School
SCHOOL G	Rural Area School

From these schools the focus was mainly on grade 10 - 12 physical science educators and learners. The schools are varied in their structures, status, resources, curriculum and staffing, all being the factors that affect the process of change. These schools were labeled A, B, C, D, E, F and G in order to identify them easily when coding the field notes made during observation.

The use of letters was meant to reveal their peculiar characteristics, as they are each unique, as well as to protect their identity in this study. In each school, the researcher made observations about the following:

- (i) Classrooms, laboratories and furniture.
- (ii) Teaching and learning materials
- (iii) Libraries
- (iv) Classroom organization/sitting arrangement
- (v) Classroom organization/ fitting arrangement
- (vi) School Policies, e.g. assessment policies, subject policies, etc.
- (vii) Resources, specifically for OBE in FET band.
- (viii) Educator-learner ratio conducive for OBE
- (ix) Assessment documents for physical science educators and Grade 10 learners doing physical science.
- (x) *Teaching and learning*

According to Grinnell (1988:133) a sample is a small portion of the total set of objectives, events or persons that together comprise the subjects of the study. It is usually impossible to involve the entire population when one does research.

Schumacher and McMillan (1993:16) also agree that a sample is selected from the population to provide subjects. A sample is thus any group which is selected on which information is obtained. It is required that a sample is drawn from a population. The population is the group that is of interest to the researcher, the group to which the researcher would like to generalize the results of the study. Elements / individuals selected from the target population

must have an equal chance of being included in the research, in the case of random sampling.

Sampling is the process of selecting a number of individuals for a study in such a way that the individuals represent the larger group from which they were selected. The reason for sampling is to reduce expenses, that is, interviews can be conducted in a shorter period of time – allowing the researcher greater co-ordination of the interviews.

The focus of the study was to investigate the educators' knowledge and understanding regarding instructional and assessment strategies, processes and procedures they commonly use in the FET band and also to investigate how they (educators) planned and implement assessment using OBE principles. The strategies the educators used in assessing learners were also investigated for the purpose of the study. The focus of the study was also on physical science professional development needs as well as parental support and involvement. Fifty percent (50%) of all learners doing grade 10 - 12 Physical Sciences per school were selected to participate in answering the questionnaires. A class list was used to select the number of learners. The reason why the researcher chose grade 10 physical science learners was because they were the first group to do NCS physical science in the FET band in 2006. Physical science is also the subject of the researcher's specialization and interest. Questionnaires were given to learners to

complete. The researcher explained questions or concepts that learners may not understand since English is their second language, which they only use at school, thus making their command of the language still on a developmental trajectory.

3.6 PERMISSION TO CONDUCT RESEARCH

With regard to permission to conduct research with the aim of administering the questionnaires to Physical Science educators and learners at Empangeni District, the researcher contacted the relevant senior educational managers, that is, District Manager, Circuit Manager of Lower Umfolozi Circuit and Ward Managers of Richards Bay, KwaMbonambi and Ngwelezane school wards. The researcher received written permission from the above-mentioned education managers to conduct the research. There was also a provision, however, that permission should be obtained firstly from the school principals. This was also done.

The fieldwork undertaken involved the use of interviews and questionnaires for collecting data. The nature of the study also warranted the use of observational methods, which enabled the researcher to assume the role of both active participant and a privileged observer (Wiersma & Gay, 1987). The following were the data that was collected through direct observation:

- Availability of classrooms;
- Physical science laboratories;

- Laboratory equipment and apparatus;
- Computer laboratories;
- Libraries; and
- Classroom furniture.

The researcher had to ascertain if schools were having adequate resources since one of the research objectives for this study was to find out the instructional strategies used by physical science educators, particularly where the necessary laboratory facilities and other attendant resources are absent or in short supply.

3.7 THE RESEARCH INSTRUMENT

Data required for this study were collected by posing questions to respondents using questionnaires for educators and learners (appendices A and B). A questionnaire is a set of questions dealing with some topics or related groups of individuals for the purpose of gathering data on a problem under consideration (Van der Aardweg & Van der Aardweg, 1988:190).

Obtaining data this way is supported by Dame (1990) in Frenkez and Wallen (1990) who asserts that the gathering of data from respondents using questionnaires is one of the most effective ways of data collection. In this regard, Behr (1988) sees questionnaires as a research tool that remains one of the best available instruments to collect data from a widely spread population.

A well-designed questionnaire is the culmination of a long process of delineating a research problem and clearly stating the research objective, for the fact that a questionnaire should be constructed according to certain principles (Kidds & Judd, 1986:128-131, Behr 1988:155-156). A poorly designed questionnaire can invalidate any research results notwithstanding the merits of the sample, the field workers and the statistical techniques. On the other hand, a well designed questionnaire can boost the reliability and validity of the data to acceptable levels tolerance (Schumacher & Mullon, 1993:42). The length of the individual questions, the number or response options, as well as the format and wording of questions are determined by the following:

- Aim of the research
- Choice of the subject to be researched
- Size of the research sample
- Method of data collection
- Analysis of the data

Against this background, it was important for the researcher to look at the principles that determine whether a questionnaire is well designed thereby drawing a distinction between questionnaire content, question format, question order, type of questions, formulation of questions, as well as the validity and reliability of questions. However, the questionnaire has its own advantages and disadvantages. They are elucidated below.

3.7.1 Advantages of the Questionnaire

According to Mahlangu (1987:96) the questionnaire is one of the most common methods of gathering information. It is also time saving and conducive to reliable results. The researcher used the written questionnaire as a research instrument taking into consideration certain advantages cited by Cohen and Manion (1989:111-112). They are as follows:

- Affordability is the primary advantage of a written questionnaire because it is the least expensive means of data gathering.
- A written questionnaire precludes possible interview bias. The way the interviewer asks questions and even the interviewer's appearance or attraction may influence respondents' answers. Such biases can be completely eliminated in the written questionnaire.
- A questionnaire permits anonymity. If it were arranged such that responses are given anonymously, the researcher's chances of receiving responses that genuinely represent a person's beliefs, feelings, opinions or perceptions would increase.
- Questionnaires can be given to many people simultaneously, that is to say that a large sample of a targeted population can be reached at the same time.
- They permit a respondent sufficient amount of time to consider answers before responding.

- They provide a greater uniformity across the measurement situations than do interviews. Each person responds exactly to the same questions because standard instructions are given to the respondents.
- Generally, the data provided by questionnaires can be more easily analyzed and interpreted than the data obtained from verbal responses.
- Using a questionnaire solves the problem of non-contact “when the researcher calls”. When the target population to be covered is widely and thinly spread, the mail questionnaire is an effective way to reach the intended respondents.
- Through the use of the questionnaire approach the problems related to interviews may be avoided. Interview “errors” may seriously undermine the reliability and validity of the survey results.
- Questions requiring considered answers rather than immediate answers could enable the respondents to consult documents in the case of the mail questionnaire.
- Respondents can complete questionnaires in their own time in a more relaxed atmosphere.
- Questionnaire design is relatively easy if guidelines are followed.
- The administration of questionnaires, the coding, analysis and interpretation of data can be done without much training.

- Data obtained from questionnaires can be compared and inferences can be made.
- Questionnaires can elicit information, which cannot be obtained from other sources. This renders empirical research possible in different educational disciplines.

3.7.2 Disadvantages of the Questionnaires

Although the questionnaire has advantages, it also has significant disadvantages. According to Van der Aardweg and Van der Aardweg (1988:190), Kidder and Judd (1986:223-224) and Mahlangu (1987:84-85) the disadvantages of questionnaires are, *inter alia*, the following:

- Questionnaires do not provide the flexibility of interviews. In an interview an idea or comment can be explored. This makes it possible to gauge how people are interpreting the question. If questions are interpreted differently by respondents, the validity of the information obtained is jeopardized.
- People are generally better able to express their views verbally than in writing.
- Questions can be answered only when they are sufficiently easy and straight forward to be understood with the given instructions and definitions.
- Written questionnaire do not allow the researcher to correct misunderstanding or answer questions that the respondents may have.

Respondents might answer questions incorrectly or not at all due to confusion or misinterpretations.

3.7.3 Characteristics of a Good Questionnaire

Throughout the construction of the questionnaire the researcher had to consider the characteristics of a good questionnaire in order to meet the requirements necessary for the research instrument to be reliable. The characteristics of a good questionnaire that were considered by the researcher were the following (Van der Aardweg & Van der Aardweg, 1988:190; Mahlangu, 1987:84-85; and Norval, 1988:60):

- A good questionnaire has to deal with a significant topic, one which the respondents will recognize as important enough to warrant spending their time on. The significance should be clearly and carefully stated on the questionnaire and on the accompanying letter. This was done in the present study.
- It must seek only that information which cannot be obtained from other sources.
- It must be as short as possible, but long enough to get the essential data. Long questionnaires frequently find their way into the waste paper basket.
- Questionnaires should be attractive in appearance, neatly organized and clearly duplicated or printed.
- Directions for a good questionnaire must be clear and complete, and important terms clearly defined.

- Each question should deal with a simple concept and should be worded as simply and straight forwardly as possible.
- Different categories should provide an opportunity for easy, accurate and unambiguous responses.
- Objectively formulated questions with no leading questions should render the desired responses. Leading questions are just as inappropriate in a questionnaire as they are in a Court of Law.
- Questions should be presented in a proper psychological order proceeding from general to more specific and sensitive responses. It is preferable to present questions that create a favorable attitude before proceeding to these that are intimate or delicate in nature. Annoying and/or embarrassing questions should be avoided if possible.

3.8 TYPES OF QUESTIONS

The types of questions used in the questionnaires are briefly discussed below.

3.8.1 Open-Ended Questions

Isaac and Michael (1995:141) say that one of the best ways to developing good objective questions is to administer an open-ended form of question to a small sample of subjects representing the target population of interest. Open-ended questions call for a free response in the respondents' own words. They provide for greater depth of response and require greater effort on the part of the respondent, which makes the return rate to be meager. It's

required, therefore, that the researcher formulates the questions in a clear and easy to understand way in order to avoid misinterpretation. The respondent writes how he/she feels about a topic and gives the background of his/her answer.

The decision to use open-ended questions in this study was motivated by Kerlinger (1970), who characterized them as flexible, thereby allowing the interviewer to probe so that she may go into more depth in order to clear any misunderstandings, as well as test the limits of the respondents' knowledge. Furthermore, open-ended questions encourage co-operation and help establish rapport with respondents. In addition, they help the interviewer to make a truer assessment of what the respondents really believe, and can also result in unexpected or unanticipated responses, which may suggest hitherto unthought-of relationships.

3.8.2 Closed Questions

Best and Kahn (1993:231) define closed questions as questions that call for short, check-mark responses. They are also called structured, restricted or closed-ended question type. They are best for obtaining demographic information and data that can be categorized easily.

The respondent can answer the items more quickly, although somewhat time-consuming for the researcher to categorize. They sometimes call for a

“yes” or “no” answer. It is easy to fill out and take a relatively shorter time to complete. It keeps the respondent on the subject. These Likert-type questionnaires are relatively objective, and fairly easy to tabulate and analyze.

The disadvantages of closed questions are:

- Respondents could be forced to choose an alternative that may not be suitable to their situations.
- Construction of closed-ended questions requires from the researcher knowledge of the full range of all possible alternatives to a question.

3.8.3 Likert-type Scale Questionnaires

One of the popular methods of measuring attitudes is the method of summated ratings, commonly referred to as the Likert-type scale. By way of definition, a Likert scale is a psychometric scale commonly used in questionnaires, and is the most widely used scale in survey research (Rensis, 1932). The Likert scale is the sum of responses on several Likert items. A Likert item is simply a statement which the respondent is asked to evaluate according to any kind of subjective or objective criteria; generally the level of agreement or disagreement is measured. Often five ordered response levels are used, although many psychometricians advocate using seven or nine levels (John, 2008).

The format of a typical five-level Likert item is:

1. Strongly disagree

2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Likert scaling is a bipolar method, measuring either positive or negative response to a statement. Sometimes a four-point scale is used; this is a forced choice method since the middle option of "Neither agree nor disagree" is not available.

This type of questionnaire (Likert-type scale questionnaire) minimizes potential errors from respondents and coders. Furthermore, Imenda (2006:121) posits that

People's participation in surveys is voluntary, a questionnaire has to help in engaging their interest, encourage their cooperation and eliciting answers as close as possible to their feelings, opinions and/or ideas in relation to the issues of interest.

A number of techniques may be used in structuring one's questionnaire.

3.9 CONSTRUCTION OF THE QUESTIONNAIRE FOR SCIENCE EDUCATORS

Questionnaire design is an activity that should not take place in isolation. In the present case, the researcher consulted and sought advice from specialists and colleagues at all times during the construction of the questionnaire (van

der Aardweg & Van der Aardweg, 1988:198). Questions to be taken up in the questionnaire should be tested on people to eliminate possible errors. A question may appear correct to the researcher, when written down, but can be interpreted differently, when asked to another person. There should be no hesitation on changing questions several times before the final formulation, keeping the original purpose in mind. The most important point to be taken into consideration in questionnaire design is that it takes time, effort and that the questionnaire will be re-drafted a number of times before being finalized. A researcher must therefore ensure that adequate time is budgeted for in the construction and preliminary testing of the questionnaire (Kidder & Judd, 1986:245). All of the above was taken into consideration by the researcher during the designing of the questionnaire for this investigation.

An important aim in the construction of the questionnaire for this investigation was to present the questions as simple and straight forward as possible. The researcher also aimed to avoid ambiguity, vagueness, bias, prejudice and technical language in the questions.

The aim of the questionnaire (Appendix A) was to obtain information regarding OBE assessment in the FET band with particular reference to physical science. The questions were formulated to determine problems associated with the implementation of OBE and its effect on school without physical science laboratories and other resources concerning the following:

- Availability of resources (including staffing)
- Teacher-pupil ratio
- Attending of workshops (for orientation and as part of on-going staff development)

Sudman and Bradburn (1982: 4) point out that questionnaire construction is one of the few activities in which plagiarism is not only tolerated but actually encouraged. Considerable attention was paid to the design of the questionnaire. The following also received major attention: content of the question, question wordings, question format, whether open or closed questions appreciated responses alternatives, open responses and scale to grade responses. The language in each questionnaire instrument was adjusted both to the level of the group to which it was to be administered and the precision of the data needed. For instance language level used on the pupil's questionnaire was lower than that questionnaire.

The questionnaire was sub-divided into five sections and questions were formulated to establish the following:

Section I of the questionnaire (Appendix A) consisted of items (1.1 to 1.23) which required the respondents to indicate their personal characteristics, such as gender, age group, qualifications, experience in teaching physical sciences, location of the school, workshops attended, competency in teaching

physical science, availability and use of resources for teaching physical science.

Section II consisted of items (1.24 to 1.35) which related to how investigations were carried out in physical science classes, which is, choosing the topic, planning the investigation, carrying out the investigation, collecting data and drawing conclusions.

Section III consisted of items (1.36 to 1.43) relating to the strategies used in supporting learners doing scientific investigations. In this section respondents were requested to indicate their perceptions related to the strategies used on five-point scale: 'never', 'seldom', 'sometimes', 'often' and 'always'.

Section IV consisted of items (1.44 to 1.53) these items required physical science educators to indicate their perceptions regarding their current professional development needs and the needs of their colleagues (other physical science educators). They were requested to rank their needs in order of most important needs to least important needs.

Section V consisted of items (i to iii). They focused on physical science educators' perceptions with regard to the way they could improve their daily practice and to indicate the kind of professional development activities they felt were needed. In this section, respondents were requested to indicate their

perceptions related to improving their daily practice on five-point Likert scale: 'strongly disagree', 'disagree', 'neither agree nor disagree', 'agree' and 'strongly agree'.

The first questionnaire (Appendix A) was designed for grades 10 - 12 physical science educators in the seven (7) selected schools from the Empangeni District. The second questionnaire (Appendix B) was designed for grade 10 physical science learners from the same schools. Physical science educators' questionnaire focused on instructional strategies, assessment strategies used by physical science educators and their professional development needs.

3.10 CONSTRUCTION OF LEARNER QUESTIONNAIRE

The aim of the learner questionnaire (Appendix B) was to obtain information regarding physical science learners' perceptions and views with regard to their understanding of the purpose of assessment and the implementation of assessment strategies in the teaching-learning situation. The question of parental support was also covered.

Items 1 to 4 of the questionnaire (Appendix B) dealt with the biographical data of the respondents such as: gender, age group and parents information.

Items 5 to 15 of the questionnaire dealt with the respondents' perceptions and views with regards to OBE assessment and the assistance they receive from

both physical science educators and parents concerning physical science. In this section respondents were requested to indicate their responses by ticking YES or NO.

Items 16 to 30 of the questionnaire dealt with hands-on activities or investigations. In this section respondents were requested to indicate their responses on five-point Likert scale: 'never', 'seldom', 'sometimes', 'often' and 'always'.

3.11 VALIDITY AND RELIABILITY OF RESEARCH INSTRUMENTS

There are two concepts that are of critical importance in understanding issues of measurement in social science research, namely validity and reliability (Huysamen, 1989:1-3). All too rarely do questionnaire designers deal consciously with the degree of validity and reliability of their instruments (Cooper, 1989:15). Questionnaires have a very limited purpose. They are often one-time data gathering devices with a very short life cycle, administered to a limited population.

There are certain ways to improve both the validity and reliability of questionnaires. Basic to the validity is asking the right questions, phrased in a non-ambiguous way, and to ensure that the items sample a significant aspect of what is intended to be investigation. In this regard, terms should be clearly

defined so that they have the same meaning to all respondents (Cohen & Marion, 1989:112-113, Cooper, 1989:60-62).

Validity and reliability are especially important in educational research because most of the measurements attempted in this area are obtained indirectly. It is therefore necessary to assess the validity and reliability of these instruments. An educational researcher is expected to include in his/her research report an account of the validity and reliability of the instruments he/she has employed.

Two instruments were used in this research study, that is, one questionnaire to grades 10 - 12 physical science educators (appendix A) and one questionnaire to grades 10 - 12 physical science learners (appendix B). The ways in which their validity and reliability were determined are described below.

3.11.1 Validity of the above-mentioned instruments:

Validity is defined by Van Rensburg, Landman and Bodenstein (1994:560) as the extent to which a measuring instrument satisfies the purpose for which it was constructed. It also refers to the extent to which it correlates with some criterion external to the instrument itself. Validity is that quality of a data-gathering instrument or procedure that enables it to determine what it was designed to determine. In general terms, validity refers to the degree to which

an instrument succeeds in measuring what it has set out to measure. Behr (1986:122) regards validity as an indispensable characteristic of measuring devices.

Dane (1990:257-258), Mulder (1989:215-217) and Van der Aardweg (1988:237) distinguish between three different types of validity:

- Content validity is where content and cognitive processes included can be measured. Topics, skills and abilities should be prepared and items from each category randomly drawn.
- Criterion validity refers to the relationship between scores on a measuring instrument and an independent variable (criterion) believed to measure directly the behaviour or characteristic in question. The criterion should be relevant, reliable and free from bias and contamination.
- Construct validity the extent to which the test measures a specific trait or construct, for example, intelligence, reasoning, ability, attitudes, etc.

In a nutshell, this means that the validity of a questionnaire indicates how worthwhile a measure is likely to be in a given situation. Validity shows whether the instrument reflects the true story, or at least sometimes approximating the truth. A valid research instrument is one that has demonstrated that it detects some "real" ability, attitude or prevailing situation that the researcher can identify and characterize (Schnetler, 1993:71).

The validity of the questionnaire as a research instrument reflects the confidence with which conclusions can be drawn from the results or evidence collected. It refers to the extent to which interpretations of the instrument's results, other than the ones the researcher wishes to make, can be ruled out. Establishing validity requires that the researcher anticipate the potential arguments that skeptics might use to dismiss the research results (Cooper, 1989:120; Dane, 1990:148-149).

In terms of measurement procedures, therefore, it is the ability of an instrument to measure what it is designed to measure. Validity is defined as the degree to which the researcher has measured what he has set out to measure (Smith, 1991: 106). This definition raises some questions:

- Who decides that an instrument is measuring what it is supposed to measure?
- How can it be established that an instrument is measuring what it is supposed to measure?

Obviously the answer to the first question is the person who has designed the study and experts in the field. The second question is extremely important. In the social sciences there appear to be two approaches to establishing the validity of a research instrument: logic and statistical evidence. Establishing validity through logic implies justification of each question in relation to the

objectives of the study, whereas the statistical procedures provide hard evidence by way of calculating the coefficient of correlations between the questions and the outcome variables (Kumar, 2005: 154).

There are various type of validity, namely, face validity, content validity, predictive validity, concurrent validity and construct validity.

Face and Content Validity

Face validity is the extent to which, on the surface, an instrument looks like it's measuring a particular characteristic. Face validity is often useful for ensuring the cooperation of people who are participating in a research study. But because it relies entirely on subjective judgment, it is not, in and of itself, terribly convincing evidence that an instrument is truly measuring what the researcher wants to measure (Leedy & Ormrod, 2005:92). The judgment that an instrument is measuring what it is supposed to is primarily based upon the logical link between the questions and the objective of the study (Kumar, 2005:154).

Content validity refers to the extent to which the content of interest has been covered by a particular measurement (Imenda & Muyangwa, 2006: 115) and (Leedy & Ormrod, 2005: 92).

The study of content validity concerns sampling procedures followed to construct or select questions to constitute a given instrument.

Content validity is also judged on the basis of the extent to which statements or questions represent the issue they are supposed to measure, as judged by a researcher and experts in the field (Kumar, 2005: 154).

For validity purposes, the researcher submitted the research instruments (Appendices A and B) to the supervisor, Professor S.N. Imenda, the Executive Dean: Faculty of Education, University of Zululand. As an expert in the field of Science Education, he went through the research instruments for this study. He looked at grammar, wording and the structure of the instruments (face and content validity). He made comments on the instruments for the attention of the researcher. The researcher attended to the comments and made changes to the instruments. As a Science Education specialist, the supervisor attended to the content of each instrument to ensure that it fell in line with the objectives of the study. The supervisor, therefore, then ascertained that the contents of the instruments had been adequately covered by the instruments (Imenda & Muyangwa 2006: 118,119). Furthermore the instruments were also cross-validated by two physical science educators (both Heads of Departments) from two schools that were not selected for participation in the study. Their comments were also used to improve the instruments.

3.11.2 Reliability of Instruments Used in this Research Study

According to Mulder (1990:209) and Van Rensburg, Landman and Bodenstein (1988:512) reliability is a statistical concept and relates to consistency and dependability. Consistency refers to the constancy of obtaining the same relative answer when measuring phenomena that have not changed. A reliable measuring instrument is one that, if repeated under similar conditions, would present the same result or a near approximation of the initial result. Van der Aardweg (1988:194) and Kidder and Judd (1988:47-48) distinguish between the following ways of establishing reliability:

- Test – retest reliability (co-efficient of stability) – Consistency estimated by comparing two or more repeated administrations of the reassuring instrument. This gives an indication of the dependability of the results on one occasion and on another occasion.
- Internal consistency reliability. This indicates how well the test items measure the same thing.
- Split-half reliability. By correlating the results obtained from two halves of the same measuring instrument, we can calculate the split-half reliability coefficient.

In essence, reliability refers to consistency, but, consistency does not guarantee truthfulness. The reliability of the question is no proof that the answers given reflect the respondents' true feelings (Dane, 1990:256), a demonstration of reliability is necessary but not conclusive evidence that the

instrument is valid. This is so because reliability refers to the extent to which measurement results are free of unpredictable kinds of error. Sources of error that affect reliability are, *inter alia*, the following (Mulder, 1989:209, Kiider & Judd 1986:45):

- Fluctuations in the mood or alertness of respondents because of illness, fatigue, recent good or bad experiences, or temporary differences amongst members of the group being measured.
- Variations in the conditions of administration between groups. These range from various distractions, such as unusual outside noise to inconsistencies in the administration of the measuring instrument, such as omissions in verbal instructions.
- Differences in scoring or interpretation of results, chance differences in what the observer notices and errors in computing scores.
- Random effects by respondents who guess or check off attitude alternatives without trying to understand them.

To ensure reliability in qualitative research, examination of trustworthiness is crucial. Seale (1999:266), while establishing good quality studies through reliability and validity in qualitative research, states that the 'trustworthiness of a research report lies at the heart of issues conventionally discussed as validity and reliability. Stenbacka (2001) argues that since reliability issues concerns measurements then it has no relevance in qualitative research. She adds that the issue of reliability is an irrelevant matter in the judgment of

quality of qualitative research. Therefore, if it is used then the 'consequence is rather that the study is no good' (Stenbacka, 2001:552). Lincoln and Guba (1985:316) argue that "since there can be no validity without reliability, a demonstration of the former (validity) is sufficient to establish the latter (reliability)". Panton (2001) contends that with regard to the researcher's ability and skill in any qualitative research that reliability becomes a consequence of the validity in a study.

To be more specific, qualitative research, Lincoln and Guba (1985: 300) construe the notion of "dependability", in qualitative research as closely corresponding to "reliability" as applied to quantitative research. To ensure reliability in qualitative research, examination of trustworthiness is, therefore, crucial.

3.11.2.1 Criteria for Judging Qualitative Research

Credibility

The credibility criterion involves establishing that the results of qualitative research are credible or believable from the perspective of the participant in the research. Since from this perspective, the purpose of qualitative research is to describe or understand the phenomena of interest from the participant's point of view, the participants are the only ones who can legitimately judge the credibility of the results (William, 2006). Both qualitative and quantitative researchers need to test and demonstrate that

their studies are credible. While the credibility in quantitative research depends on instrument construction, in qualitative research, "the researcher is the instrument" (Patton, 2001: 14). Thus, it seems when quantitative researchers speak of research validity and reliability, they are usually referring to a research instrument that is credible while credibility of a qualitative research depends on the ability and effort of the researcher. Although reliability and validity are treated separately in quantitative studies, these terms are not viewed separately in qualitative research. Instead, terminology that encompasses both, such as credibility, transferability, and trustworthiness is used (Golafshani, 2003: 600).

Transferability

Transferability refers to the degree to which the results of qualitative research can be generalized or transferred to other contexts or settings. From a qualitative perspective, transferability is primarily the responsibility of the one doing the generalizing. The qualitative researcher can enhance transferability by doing a thorough job of describing the research context and the assumptions that were central to the research. The person who wishes to "transfer" the results to a different context is then responsible for making the judgment of how sensible the transfer is likely to be (William, 2006).

Dependability

The traditional view of reliability is based on the assumption of replicability or repeatability. Essentially, reliability is traditionally concerned with whether we would obtain the same results if we could observe the same thing twice. But we can't measure the same thing twice in qualitative research settings – by definition if we are measuring the same thing twice, we are measuring two different things. In order to estimate reliability, qualitative researchers construct various hypothetical notions (e.g., true score theory) to try to get around this fact. The idea of dependability, on the other hand, emphasizes the need for the researcher to account for the ever-changing context within which research occurs. The research is responsible for describing the changes that occur in the setting and how these changes affected the way the research approached the study (William, 2006).

Confirmability

Confirmability refers to the degree to which the results could be confirmed or corroborated by others. There are a number of strategies for enhancing confirmability. The researcher can document the procedures for checking and checking the data throughout the study. Another researcher can take a “devil’s advocate” role with respect to the results, and this method can be documented (William, 2006).

3.11.2.2 Triangulation

Triangulation refers to the use of multiple approaches in data collection with the hope that the data so-collected will all converge to support a particular hypothesis or theory. Triangulation is especially common in qualitative research. For instance, a researcher might engage in many informal observations in the field and conduct in depth interviews, and then look for common themes that appear in the data gleaned from both methods. Triangulation is also common in mixed-method designs, in which both quantitative and qualitative data are collected to answer a single research question (Leedy, 2005: 99).

Reliability and validity are conceptualized as trustworthiness, rigour and quality in the qualitative paradigm. It is also through this association that the ways to achieve validity and reliability of a research get effected, from the qualitative researcher's perspective, which is to eliminate bias and increase the researcher's truthfulness of a proposition about some social phenomenon (Denzin, 1978). In a nutshell, therefore, triangulation is defined to be "a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study" (Creswell & Miller, 2000: 126). More than one instrument were used to collect data for this research study, that is, questionnaires (Appendices A & B), and the purpose being that the research was qualitative in nature.

3.12 PILOT STUDY

The pilot study is a preliminary or “trial run” investigation using similar questions and similar subjects as in the final study. The basic purpose of a pilot study is to determine how the design of the subsequent study can be improved and to identify flaws in the measuring instrument (Kidder & Judd, 1986 211-212). A pilot study provides the researcher with an idea of what the method will actually look like in the operation and what effects (intended or not) it is likely to have. This implies that by generating many of the practical problems that will ultimately arise, a pilot study enables the researcher to avert these problems by varying procedures, instructions and questions.

According to De Vaus (1990: 105) a pilot study has various advantages, which prompted the researcher to use it in the project under study. These advantages, amongst others, are that it:

- Permits a thorough check of the planned statistical and analytical procedures, thus allowing an appraisal of their adequacy in treating data.
- Provides the research worker with ideas, approaches and clues not foreseen prior to the pilot study. Such ideas and clues greatly increased the chances of obtaining clear-cut findings in the main study.

According to Plug, Meyer, Louw and Gouws (1991: 49-66) the following are the purposes of a pilot study, and these were also the aim of the researcher in the present investigation.

- It greatly reduces the number of treatment errors in the sense that unforeseen problems revealed in the pilot study are then used to redesign the main study.
- It saves the researcher major expenditures of time and money on aspects of the research that may have been unnecessary.
- Feedback from other persons involved is possible, leading to important improvements in the main study.
- In the pilot study, the researcher tries out a number of alternative measures and selects only those that produce the best results for the final study.
- The approximate time required to complete the questionnaire was established in the pilot study.
- Questions and/or instructions that are misinterpreted are reformulated.

In order to identify the weaknesses in the questionnaire, and to test for ambiguity and clarity of wording, it was necessary to conduct a pilot study. The pilot served as a trial run for the final administration of the questionnaires.

For the purpose of the pilot study in this research project, three (3) grades 10 - 12 physical science educators were selected amongst the researcher's

colleagues as well as thirty (30) grades 10 - 12 physical science learners. A trial run questionnaire (earlier version of appendix A) was administered to science educators and an earlier version of the questionnaire in Appendix B was administered to physical science learners. These educators and learners were drawn from schools not selected for the main study.

The results of the pilot study suggested that a few changes were necessary. Some of these items had to be re worded after some teachers left out some of the crucial questions. The same was observed with regard to the learners' questionnaire. Indeed, these trial runs proved to be invaluable in refining the instruments.

Through the utilization of the pilot study as "pre-test" the researcher was satisfied that the questions asked in the respective two questionnaires complied adequately with the requirements of the study.

3.13 THE PROCESSING OF THE DATA

Once data were collected, they were captured in a format which permitted analysis and interpretation. This involved the careful coding of the 16 questionnaires completed by the educators, 320 questionnaires completed by grade 10 physical science learners and also coding the information captured through and observations. The coded data were subsequently transferred onto a computer spreadsheet. School A had 4 educators, school B had 3

educators, and each school from school C to school G had 1 educator teaching physical science in grade 10, 11 and/or 12.

3.14 DATA COLLECTION PROCEDURE

The researcher used questionnaires and observation schedules for data collection with regard to factors associated with OBE assessment in the FET band, with particular reference to physical science. The research was conducted among grades 10 - 12 physical science educators. All races were included in this research, that is, educators and learners.

The research was conducted mostly through questionnaires as stated above. Sibaya (1993), states that a questionnaire is not just a list of questions or forms to be filled in, but it is a scientific instrument for the measurement and collection of a particular kind of data. Questionnaires were fetched by principals of schools from the lower Umfolozi Circuit office, where they were left by the researcher. The SEM's made it their responsibility to distribute questionnaires to school principals. Questionnaires were collected from schools at the time agreed upon by the researcher.

3.15 DATA COLLECTION METHODS

Administration of the questionnaire

If properly administered the questionnaire is the best available instrument for obtaining information from widespread sources or large groups

simultaneously (Cooper, 1989:39). The researcher personally delivered the questionnaires to the ward managers, that is, Richards Bay Ward Manager, Ngwelezane Ward Manager and Kwa-Mbonambi Ward Manager. These managers are also called the Superintendent of Education Managers (SEM's). The ward managers formally distributed the questionnaires to the seven selected schools in Empangeni District. The researcher then went to schools to do observation, and to collect the questionnaires. The questionnaires for grade 10 - 12 physical science learners were designed to investigate the learners' experiences of assessment, how and when it is done and whether it does enhance their performance.

3.16 LIMITATIONS OF THE STUDY

The following limitations of the study are highlighted for future research:

3.16.1 The sample of this study was drawn from schools of Empangeni District only; therefore, it is not representative of the entire population of educators and learners in other districts and regions. Consequently, further studies need to be conducted in other circuits, districts and regions to corroborate or negate the findings reported in this study.

3.16.2 Only public schools were included in the targeted population, and therefore the research sample. Further research focusing on private schools is needed.

3.16.3 This study focused on the challenges facing physical science educators in the implementation of the NCS in the FET band only, that is,

grades 10 - 12. There is a need for a study in other FET subjects and at other grade levels as well.

3.16.4 The sample of this study consisted of only sixteen (16) physical science educators and three hundred and twenty (320) learners. More research, with a bigger sample, preferably a regional, provincial or national study would shed more light on the topic that has been investigated.

3.17 CONCLUSION

This chapter has presented the research design, procedures and methods of study used in this research. Research tools and techniques have been discussed. The researcher did not encounter problems with access to schools and the principals were willing to share as much information as they could. The next chapter will focus on the presentation and analysis of the research findings.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter presents the analysis, interpretation and discussion of findings on the data collected for a study on the challenges facing physical science educators in the implementation of the NCS. These challenges were, *inter alia*, parental involvement and support, instructional and assessment strategies commonly used by physical science educators and professional development needs of physical science educators. As explained in chapter 3 the data were collected by means of observations and questionnaires for educators and learners drawn from the Empangeni Education District.

In this chapter, the researcher focuses on the analysis and the interpretation of data collected through questionnaires. Open questions were used to encourage respondents to expand on comments and offer opinions about the use of OBE resources and the introduction of OBE in the FET band.

The purpose of this study was to investigate the challenges facing physical science educators in the implementation of the NCS and the assessment strategies they used.

The results are categorised as follows:

- Biographical information of respondents;
- Facilities and resources used in physical science teaching and learning;
- Instructional approaches used by physical science educators;
- Assessment strategies used by physical science educators;
- Professional development of physical science educators;
- Discussion of results; and
- Conclusion.

4.2 PRESENTATION OF RESULTS

This section presents the biographical information of the respondents, that is, for both educators and learners.

4.2.1 Biographical Information

There were seven schools that participated in the study. This constituted ten percent (10%) Empangeni Education District. There are 73 high schools Empangeni District altogether. The learner questionnaire was completed by 320 learners and the physical science educator questionnaire was completed by 16 physical science educators.

4.2.1.1 Gender Distribution of Learner Respondents

Table 4.1 below shows the gender distribution of the sample of physical science learners who participated in the study.

Table 4. 1 *Gender Distribution of respondents (n=320).*

GENDER	Frequency	%
Male	131	41
Female	189	59
TOTAL	320	100

Table 4.1 indicates that the research sample consisted of more girls than boys. In total, there were 320 learners who responded to the above question, that is 131 boys (41%) and 189 girls (59%). It's pleasing to see that many female learners are interested in physical science. The above analysis includes all races, that is Blacks, Coloureds, Indians and Whites. The researcher did not do the analysis according to race.

4.2.1.2 Age Distribution of Learner Respondents

Table 4.2 below shows the age distribution of the learners who participated in the study.

Table 4. 2 *Age Distribution of respondents (n=320).*

AGE	Frequency	%
Under 15	33	10
15	171	53
16	85	27
16+	31	10
TOTAL	320	100

Tale 4.2 indicates that the majority of learners in the research sample were 15 and 16 years old. Relatively fewer learners were older than 16 years of age. There were 171 learners (53%) who were 15 years old and 85 learners (27%) who were 16 years old. Only 33 learners (10%) were under 15 years old and also 31 learners (10%) were more than 16 years old. It's pleasing to note that these relatively young people had taken the choice to study physical science, which has been prioritised by government as one of the fields of study associated with the future development of the country.

4.2.1.3 Learners Living With Parents or Guardians

Table 4.3 shows the distribution of learners living with or without their parents, or staying with guardians. This information helped to check if learners did get assistance with regard to school work or parental assistance as one of the research questions.

Table 4.3: Home status of *learners (living with their parents or guardians)* (n=320).

Parent/Guardian	Frequency	%
Both parents	174	54
Father only	26	08
Mother only	79	25
Guardian	41	13
TOTALS	320	100

Table 4.3 indicates that the majority of the learners in the research sample lived with both their parents, followed by those learners who lived with their mothers only. Relatively fewer learners stayed with their fathers only, as well as guardians. In total, there were 174 learners (54%) living with both parents, 79 learners (25%) living with their mothers only. There were 26 learners (08%) living with their fathers only and 41 learners (13%) living with their guardians. Learners staying with both parents are likely to get more support in their school work.

In the learners' questionnaire, questions 8 – 13 were not analysed. The researcher's interest with learner questionnaire was to collect information on how parents support the education of their children. These questions were not addressing the research question that related to parental involvement in the education of their children.

4.2.2 Biographical Information of Educator Respondents

4.2.2.1 Participating Schools and Number of Educators

Sixteen, educators from 7 high schools completed the questionnaires. Table 4.4 reflects the type of schools that participated in this study, as well as the number of educators that constituted the research sample.

Table 4.4: Participating schools

SCHOOL	NUMBER OF EDUCATORS	SITUATION / LOCATION
A	4 Educators	Urban Area School (ex-Model C)
B	3 Educators	Urban Area School (ex-Model C)
C	2 Educators	Urban Area School (In Township)
D	2 Educators	Urban Area School (In Town)
E	2 Educators	Urban Area School (ex-Model C)
F	2 Educators	Rural Area School
G	1 Educator	Rural Area School

4.2.2.2 Gender Distribution of Educator Respondents

Table 4.5 shows a gender distribution of the sample of physical science educators who participated in the study.

Table 4.5: *Gender distribution of educator respondents (n=16).*

GENDER	Frequency	%
Male	8	50
Female	8	50
TOTAL	16	100

Table 4.5 indicates that there was gender balance amongst the physical sciences educators comprising the research sample. According to the above table, 50% respondents were males and 50% were females. It was also gratifying to see such a balance in the educator composition. In terms of role-modelling, it's important for female learners to see that physical science is as much a subject for males as it is for females.

4.2.2.3 Age of Educator Respondents

Table 4.6 shows the age distribution of the research sample comprising physical science educators who participated in the study.

Table 4.6: *Age of educator respondents (n=16).*

AGE	Frequency	%
Under 30	03	19
30 – 39	07	43
40 – 49	03	19
50 – 59	03	19
60+	00	00
TOTAL	16	100

From Table 4.6 it is clear that there are many young educators teaching physical science in the FET band. The table shows that the highest percentage is 43%, falling in the age range 30 – 39 years. These educators still have many years of service to the school system. Young educators should network with older educators to benefit from the latter's experience.

4.2.2.4 Post Level

Table 4.7 presents the post level distribution of the educator participants.

Table 4.7 *Post levels held by educators in the research sample (n=16).*

Rank	Post level	Frequency	%
Principal	4	0	00
Deputy Principal	3	3	19
H.O.D	2	5	31
Educator	1	8	50
	TOTAL	16	100

Table 4.7 indicates that the majority of the participating educators were in post level one, that is, 8 educators (50%), 5 educators (31%) who were Heads of Departments (H.O.Ds) (post level two) and 3 educators (19%) who were deputy principals, that is, post level three. There were no principals teaching physical science.

4.2.2.5 Physical Science Teaching Experience

Table 4.8 shows the teaching experience of the participating educators in years.

Table 4.8 *Educator experience in teaching physical science (n=16).*

YEARS	Frequency	%
0-5 years	0	00
6-10 years	6	38
11-15 years	5	31
16-20 years	1	06
20+ years	4	25
TOTALS	16	100

Table 4.8 shows that all educators had at least six years of teaching experience. There were no educators with teaching experience of 5 years or less. The first group (38%) were those that had between 6 and 10 years of service; followed by 31% of the respondents with between 11 and 15 years of experience. One respondent (6%) had between 16 and 20 years of service,

which is the lowest percentage, while 4 respondents (25%) had teaching experience of 20 years and above. Overall, it may be said that this research sample was well experienced. One would therefore rely on the responses of such a research sample.

4.2.2.6 Posts held

Table 4.9 shows the frequency distribution according to posts held by the educator respondents.

Table 4.9 *Post held by the educator respondents (n=16).*

Post	Frequency
Permanent	12 (75%)
Temporary	4 (25%)

Table 4.9 indicates that the majority of the physical science educators were permanently employed, that is, 12 educators (75%) and there were relatively fewer temporary educators, that is, 4 educators (25%).

4.2.2.7 Employment Status of Educators

Table 4.10 shows the frequency distribution according to the employment status of the educator respondents.

Table 4.10 *Frequency distribution according to employment of educators (n=16).*

EMPLOYMENT	FREQUENCY
Department of Education	14 (87, 50%)
Governing Body	2 (12, 50%)

Table 4.10 indicates that the majority of the educators were employed by the Department of Education, (87.50%) and 2 (12,5) were employed by school governing bodies.

4.2.2.8 Academic and Professional Qualifications of the Respondents

Table 4.11 shows the academic and professional qualifications of respondents. The data were collected as shown in the table below:

Table 4.11 *Qualifications of respondents (n=16)*

QUALIFICATIONS	Frequency	%
Academic Qualifications (e.g. B.A., B.Sc. etc)	4	25
Professional Qualifications (e.g. H.E.D., U.E.D., ACE, etc.)	12	75
TOTALS	16	100

Table 4.11 indicates that 25% of the respondents did not have professional qualifications, although they held university degrees; 75% of the respondents

held professional teaching qualifications. It is assumed that as qualified educators they stood a better chance of understanding the OBE instructional process, related concepts and how resources should be used in the OBE context.

4.3 SUPPORT RECEIVED FROM PARENTS AND GUARDIANS

The first research question sought to determine the level of parental support received by the learners, particularly with regard to physical science. Table 4.12 presents the employment status of the parents of the learners who participated in this study.

Table 4.12 below shows the employment status distribution of parents.

Table 4. 12: *Parents' employment status (n=320).*

Employment status	Frequency	%
Unemployed	32	10
Self-employed	45	14
Employed	229	72
Other	14	04
TOTALS	320	100

Table 4.12 indicates that the majority of parents, as reported by learners, were employed. There were 32 parents (10%) who were unemployed, 45 parents (14%) who were self-employed, 229 parents (72%) who were

employed and 14 parents (04%) who fell under the 'other' category. On the whole the table shows that fewer learners had parents who were not employed. Learners with working parents are likely to be more supported with regard to school learning materials. However, the researcher found that learners with working parents did not have sufficient learning materials for physical sciences, for example, mathematics set of instruments, scientific calculators. Textbooks were supplied by the Department of Education, though they arrived late in schools

Table 4.13 shows learners who got assistance from their parents with regard to school work especially parent assessment since it is one of the methods used in OBE.

Table 4.13 Frequency distribution of learners receiving help from parents with respect to assessment and learning (n=320).

Learners	Frequency	%
Yes	281	89
No	39	11
TOTAL	320	100

Table 4.13 shows that most learners received help from their parents with respect to assessment and their learning, in general. There were 281 learners (89%) who reported receiving help from their parents and guardians and 39 learners (11%) who were not receiving help from parents and guardians with

respect to assessment. Very few learners reported not receiving help from their parents. There may be a number of reasons for this. Illiteracy of parents might be one of the reasons.

Regarding parental support and involvement, there were 174 (54%) learners who were living with both parents and 13% of the learner respondents reported that they were not staying with their parents but with their guardians. Learners staying with both parents are likely to get more support in their school work, including assessment. Relatively fewer learners stayed with their fathers and mothers only. There were 281 (89%) learner respondents who reported that they were receiving help from parents and guardians with respect to school work. On the other hand, the research conducted by Shilubana and Kok (2007:101-107) revealed that learners without adult care at home can succeed at school very well provided they get strong support from their guidance teachers, peers, neighbours and extended families. According to Shilubana and Kok (2007:103) the following could be the reasons why some learners did not stay with parents:

- Lack of employment opportunities;
- Death of parents, predominantly due to the AIDs pandemic;
- Single parents who choose to stay with their loved ones somewhere else; and
- Negligence by parents.

The reality of the South African economy is such that not all provinces are equal in terms of wealth or economic activity. As a result, some economically active parents have to move within and between provinces to get employment. Even though others still remain within the province, they have to work in neighbouring towns, or cities far away from home, which have better opportunities of employment, leaving children alone at home (Shilubana & Kok, 2007:102).

Shilubana and Kok (2007:105) further posit that “the unavailability of parents puts a lot of strain on learners, not only affecting their school performance, but also their emotional state”. Donald, Lazarus, and Lolwana, (1997) and Gololo (1998) argue that the success of any learner does not depend on him or her alone, but on factors such as parental support, the role played by the school, especially the teachers, extended family members and the community.

Certainly, parents are expected to give support to the children’s learning and school education in various ways – including material, emotional and intellectually. Thus the importance of the role played by parents cannot be over emphasised.

There were 229 (72%) learner respondents who reported that their parents were working, 10% of the learner respondents had parents who were not working and 14% of the parents were self-employed. Learners with working parents are likely to be more supported with regard to school learning

materials. According to Smit and Liebenberg (2003:1), “research relating to parental involvement in schooling, especially within South Africa, is limited as well as highly restricted to wealthier social groups”. Shilubana and Kok (2007:102) argue that most focus is on the negative consequences of lack of parental involvement, and little has been done to investigate factors that contribute towards learner achievement in the absence of parents. With regard to the first research question, the main finding was that the majority of learners (89%) received help from their parents and guardians with respect to assessment.

4.4 INSTRUCTIONAL STRATEGIES USED BY THE EDUCATORS

The second research question sought to document and reflects on the instructional strategies used by the physical science educators in the implementation of the NCS. Of special interest to the researcher were the ways in which the NCS was being implemented, particularly in schools that were not well-resourced.

Table 4.14 shows educators’ responses regarding instructional approaches they use in the teaching and learning of physical science. In the first column statements are not stated in full to save space but are stated below the table before the interpretation of the findings.

Table 4.14 Frequency of use of various instructional approaches (n=16)

Instructional Approach	Always	Regularly	Sometimes	Never	Total	%
Lecture	5 (31)	9 (56)	2 (13)	0 (00)	16	100
Problem Solving	2 (13)	5 (31)	9 (56)	0 (00)	16	100
Direct Instruction	7 (44)	4 (25)	5 (31)	0 (00)	16	100
Hands-on Activities	1 (06)	4 (25)	8 (50)	3 (19)	16	100
Experimentation	0 (00)	3 (19)	9 (56)	4 (25)	16	100
Demonstration then experimentation	2 (13)	4 (25)	6 (38)	4 (25)	16	100
Question & Answer	7 (44)	4 (25)	5 (31)	0 (00)	16	100
Accommodate prior knowledge	8 (50)	4 (25)	4 (25)	0 (00)	16	100
Debate	10 (63)	6 (38)	0 (00)	0 (00)	16	100
Mastery learning	9 (56)	4 (25)	3 (19)	0 (00)	16	100

(Percentages are in brackets)

Table 4.14 reveals the following information pertaining to educators' responses to each item:

Statement 1: I use lecture (telling method) to clarify a concept.

To this statement, 31% of the educators reported that they **always** used lecture method to clarify concepts; 56% **regularly** did so and 13% **sometimes** used lecture method. The majority response was that most educators regularly used the lecture method to clarify concepts. The following were educators' brief comments:

"Learners should be exposed to varying learning styles for motivation."

"I use lecture together with a demonstration on the board."

"I use lecture method to clarify new concepts".

"Language barrier makes simpler explanations necessary".

"To introduce new concepts which need teacher engagement".

"Learners have poor reading skill and this method (lecture) is effective".

"When new concepts are introduced I explain them to learners by lecturing".

Statement 2: I engage learners to problem solving in small groups.

In this regard, 13% of the educator respondents reported that they **always** engaged learners in problem solving in small groups; 31% reported to do so **regularly** and 56% **sometimes** engaged learners in problem solving in small groups. It is clear from these percentages that the engagement of learners in problem solving in small groups by educator respondents was minimally done. The following were educators' brief comments related to this statement:

"I engage learners in problem solving in small groups to induce learner-to-learner learning process."

"Problem solving is usually done as a class as it takes more time with small groups."

"Amongst learners there are those that are gifted and those that are slow. "Using small groups motivates them as they share ideas".

"Time constraints compel me to use quicker teaching methods"

"I am dealing with big classes and so small groups are impossible".

"Learners need to learn from each other as well".

"Problem solving is usually done as a class (individual learners) as it takes more time with small groups".

"Some learners do not involve themselves in group discussions".

"Not all the work is done in groups, at times I engage in individual attention".

"I have more than sixty learners in the class; it is hard to make small groups. I therefore use larger groups".

Statement 3: I use direct instruction (explanations) to help learners acquire factual knowledge.

Regarding the use of direct instructional approaches, 44% of the educator respondents reported that they **always** used direct instructions to help learners acquire factual knowledge; 25% did so **regularly** and 31% **sometimes** used direct instructions. The following were some of the educators' brief comments on this matter:

"I use direct instruction for clarity of concepts, especially for the slow learners." "I usually use a different situation related to the problem to help learners acquire factual knowledge".

"This is the best an educator can use to ensure that learners receive the facts about what they are learning".

"Learners are not used to self discovery, they are not trained to learn to discover".

"I empower learners through hands-on exploration in the context of science problem solving especially when dealing with new concepts"

"Sometimes learners are allowed finding information on their own".

"Explanations help learners to grasp the concepts".

Statement 4: I empower learners through hands-on exploration (manipulative skill development) in the context of science problem solving.

To this statement, 6% of the educator respondents reported that they **always** empowered learners through hands-on exploration in the context of science problem solving, 25% of the educator respondents **regularly** did so; 50% **sometimes** empowered learners through hands-on exploration and 19% **never** did so. Here, as well, the empowerment of learners through hands-on exploration in the context of problem solving by educators was minimally done. The following brief comments were given by the educator respondents:

"Some of the learners still struggle having to reason problems from theory".

"Lack of resources limits giving a chance to explore".

"I empower learners through hands-on exploration in the context of science problem solving if the material is available for that particular content".

“Hands-on makes it hard for learners to forget what they had learnt”.

“Hands-on exploration is possible if there are enough resources”.

“Hands-on exploration as an instructional strategy depends on the concepts to be learnt”.

Statement 5: I allow learners to conduct experiments (resource tasks) on their own and arrive at conclusions by themselves (discovery learning).

In this regard, 19% of the educator respondents reported that they **regularly** allowed learners to conduct experiments on their own and arrived at conclusions by themselves, 56% of the educator respondents reported that they **sometimes** allowed learners to conduct experiments and 25% **never** allowed learners to conduct experiments on their own. The picture that emerges here is that the educators rarely allowed learners to conduct experiments on their own and arrive at conclusions by themselves. However, “sometimes” was the majority response. The following were brief comments given by educator respondents:

“Allowing learners to conduct experiments on their own takes time to set up apparatus for them. I therefore need a laboratory assistant”.

“Lack of laboratory material hinders one to give learners a chance to do experiments”.

“Allowing learners to conduct experiments is time consuming due to the big number of learners in class”.

“Allowing learners to conduct experiments on their own and arrive at conclusions by themselves encourages learners to develop critical thinking skill”.

Statement 6: In case of experiments, I do demonstrations and then allow learners to practise the skill for themselves under my supervision.

To this statement, 13% of the educator respondents reported that they **always** did demonstrations and then allowed learners to practise the skills for themselves under their supervision; 25% of the educator respondents reported that they **regularly** did so; 38% **sometimes** did so and 25% **never** did so. The picture that emerges here, as well, is that the educators rarely did demonstrations, although again “sometimes” was the majority response at 38%. The following were comments that were given by educator respondents:

“I do demonstrations and allow learners to practise the skill for themselves under my supervision when necessary, depending on the learning outcomes and assessment standards”.

“Allowing learners to practise the skill after demonstration is not done for all experiments”.

“Large numbers in classes make it hard to allow learners to practise the skill, after a demonstration by the teacher”.

“Allowing learners to observe a demonstration and then practise the skill for themselves helps the learner to understand the theory as well”.

“Demonstration assists our learners to observe the steps and also be aware of the precautions”.

Statement 7: I allow learners to question, investigate and seek out information in order to help their higher-order and critical thinking skills.

In this regard, 44% of the educator respondents reported that they **always** allowed learners to question, investigate and seek information out in order to help them develop their higher-order and critical thinking skills, 25% of the educator respondents reported that they **regularly** did so and 31% **sometimes** did so. The majority response at 44% suggests That the educator respondents “always” allowed learners to question investigate and seek out information in order to develop their higher-order and critical thinking. Educator respondents gave the following brief comments in this regard:

“To let and train learners to develop reasoning skills”.

“While this is done to improve learners’ skills, learners are lazy to seek out information and the teacher ends up helping them”.

“Learners can be referred to books for more information”.

“Allowing learners to question, investigate and to seek out information helps to ensure that they well understand what was being taught and seeking information helps them to know how to work independently”.

“It helps the learners to relate the concepts with the things happening in the world”.

“Investigations and seeking out information is not done in all activities”.

“It gives learners a sense of discovering and grasping the concepts solidly”.

“Allowing learners to question, investigate and to seek out information helps to let and train learners to develop reasoning skill”.

Statement 8: I accommodate learners' level of prior knowledge and different learning rates.

To this statement, 50% of the educator respondents reported that they **always** accommodated learners' levels of prior knowledge and different learning rates, 25% of the respondents reported that they **regularly** did so and 25% **sometimes** did so. This meant that, half of the educator respondents “always” accommodated learners' levels of prior knowledge and different learning rates. Educator respondents gave the following brief comments regarding this statement:

“Concepts are developed from the known to unknown”.

“Due to this, learners always forget what has been done before, hence, slow coverage of the year work programme”.

“Accommodating learners' level of prior knowledge and different learning rates makes it easy to know what they know and proceed accordingly”.

“Accommodating learners’ level of prior knowledge and different learning rates makes learners to be confident”.

“I fail to do this for all learners because of overcrowding in classes but those who come to me get my full attention”.

“Concepts are developed from the known to the unknown”.

Statement 9: I encourage learners to express their own thoughts and ideas.

In this regard, 63% of the educator respondents reported that they **always** encouraged learners to express their own thoughts and ideas, 38% of the educator respondents reported that they **regularly** did so. The majority of the respondents fell between encouraging learners to express their own thoughts and ideas always and regularly. This was a good result. The following brief comments were given by educator respondents:

“I encourage learners to express their own thoughts for self evaluation and criticism”.

“Encouraging learners to express their own thoughts and ideas is done to motivate learners as well as getting other ideas or different ways of solving a problem”.

“It makes possible a chance to give guidance”.

“Encouraging learners to express their thoughts and ideas assists an educator to find out their interest in his or her lesson and if this is done in class it creates a positive learning environment”.

"I only allow ideas related to the concepts being studied".

"This makes learners to be part and parcel of the lesson".

"This empowers learners in critical thinking".

Statement 10: I base instruction on mastery of skills and/or concepts.

To this statement, 56% of the educator respondents reported that they **always** based instruction on mastery of skills and/ or concepts, 25% reported that they **regularly** did so and 19% **sometimes** based instruction on mastery of skills and/or concepts. Here, as well, the majority response fell under "always" and "regularly". The following comments were given by educator respondents in this regard:

"Mostly knowledge is acquired from doing and little from listening".

"When learners master skills, they are able to apply them in any context where necessary".

"Basing instruction on mastery of skills and/or concepts is only done for gifted learners".

"If the concepts are mastered properly, learners understand the work".

"Basing instruction on mastery of skills is an important part that should be played by the science educators in instilling skills as well as concepts".

Question 11: What would you consider to be the link between assessment and instructional (teaching-learning) approaches?

The following educator respondents' remarks regarding the link between assessment and instructional approaches were gleaned from the above question:

"Assessment is a tool to measure whether teaching-learning has taken place. Without assessment it is difficult to diagnose whether one has learnt something. Therefore assessment cannot be divorced from teaching-learning".

"Assessment allows the educator to know whether his/her approaches are good for the learners or not and is a kind of feedback from learners to the teacher's instructional approaches".

"Teaching and learning approaches are very important since the assessment would be difficult and cannot be possible without it".

"Assessment helps the educator and the learners to evaluate themselves. Teachers assess their teaching methods in relation to

their learners. Learners assess whether they are learning effectively and adjust accordingly should there be a need”.

“Assessment gives one time to reflect on what was achieved in the learning process; thereby one can see the response to what was done”.

“Assessment helps to judge how far your learners are doing and if you are applying the correct teaching-learning approaches”.

Question 12: In practice, how do you relate assessment to your instructional approaches?

The following educator respondents' remarks regarding how they related assessment to their instructional approaches were gleaned from the above question:

“Assessment standards guide the manner in which I select the content to teach and assess”

“As soon as a concept is taught then assessment follows, it can be in what ever form, as long as it checks if a skill has been developed.”

“Assessment is based on instructional approaches so that learners are able to follow instructions and methods demonstrated by the educator as well as their own correct methods.”

“I relate it as a tool for finding out the understanding of what has been taught in class. It is that of checking whether learning outcomes and assessment standards are being met and being considered as well. It is also easy for an educator to identify learners with special needs or learning difficulties”.

“During instructional time (lecture), learners must develop listening skill which they use for information attainment. This is made evident during assessment”.

“Assessment is done to check the prior knowledge and prepare for new lesson. The two are connected”.

Question 13: Are there any comments you would like to make regarding this topic?

The following comments were made by educators with regard to instructional strategies as a topic:

“More volumes and volumes of books to be written and be given to educators from all walks of life, that is, about assessment versus teaching-learning”

“Using different strategies in teaching our learners helps in ensuring that our learners do gain knowledge and their involvement makes them to be active and concentrate on the lesson”.

“Current forms of assessment limit educators to conduct tests and other activities according to the Department of Education requirements. Educators do not expose or give as many assessment tasks as necessary because of a lot of administration work associated with assessment”.

“In the OBE (NCS) the instructional approach is essential as well, and as a result cannot be entirely excluded in the teaching and learning process”.

“There is a need for teachers to be taught more thoroughly concerning this topic, that is, ‘instructional approaches’”.

“Assessment is very important in order to find out whether learning outcomes have been achieved”.

The investigation revealed that there was a challenge with regard to the availability of facilities and resources for teaching and learning physical science. About 19% of educators did not receive resources for teaching physical science, that is, Subject Assessment Guidelines (SAG), Learning Programme Guidelines (LPG), content documents and micro kits for doing practical demonstrations. About 38% did not get help from the school management with regard to resources; 81% received the material for OBE from workshops, but reported that they still needed more training on how to use the material received. De Waal (2004:63) is of the opinion that

Lack of appropriate learning support material further frustrates teacher as well as learners. This also hinders effective classroom practice insofar as it restricts the learner's visual perspectives as well as self-learning abilities.

Some commentators believe that in approximately 60 percent of schools the conditions are so critical that no improvement of learner achievement will be possible until massive reconstruction is done to upgrade the facilities, the management, the teachers and the culture of learning. A complex system such as OBE will disrupt these schools more, causing learner achievement to sink even lower (Bernstein, 1996; Dallas, 1999; Taylor, 1999).

It is the view of Jacobs, et al (2002:107):

The Department of Education frequently fails to supply schools with teaching materials such as textbooks, furniture and stationery. Thus, while teachers may be willing to implement OBE, there is doubt whether they will regularly receive the necessary documents, books, and other resources to put the system into practice.

The respondents also gave information regarding the availability of facilities and resources in their schools. About 56% of the participating schools were poorly resourced; 19% were adequately resourced and 6% were well resourced; there was no school without resources at all. About 29% of the schools reported having their resources in good condition, whereas the resources in 71% of the schools were reported not to be in good condition. The reasons for the bad condition of the resources in the schools where this was the case were that in some schools science laboratories were vandalised and some schools had no laboratories at all. In some cases, chemicals had already reacted and were old, hazardous and/or had expired. Some facilities needed repair. In this regard, De Waal (2004:64) asserts that

a lack of fundamental resources such as laboratories, computer centres, libraries, inadequate school furniture, infrastructure and proper sport facilities are also viewed as constraints that are not conducive to successful education transformation.

This investigation further revealed that educators were teaching big classes of about 50 to 60 learners, and sometimes above. The majority of the educators preferred an educator-learner ratio of 30 learners to one educator. They gave a number of reasons to support the desired ratio – including that it would be easy to control, assess, manage and discipline a small group of learners. This is in support of the view of De Waal (2004:63) who points out that a big class “leads to class management problems as well as weaker learners not getting sufficient attention in terms of remedial work and academic backlogs”. De Waal (2004:65) further argues that “available teachers are thus overloaded in terms of teacher-learner ratio, which makes the facilitation of OBE difficult, if not impossible”.

Regarding teaching and learning methods, 56% of the educator respondents reported that they regularly used the lecture method to introduce or clarify new concepts. The engagement of the learners in problem solving was minimally done. The respondents stated that problem solving was usually done as a class as it took more time with small groups. They justified this by pointing out that since they were dealing with large classes, small groups were impossible. However some of the respondents engaged learners in small group problem solving activities to enhance learner-to-learner interactions.

Overall, the respondents reported that the teaching methods they used depended on the concepts to be taught or learnt. They further reported that among the learners there were those that were gifted and those that were slow learners, using small groups motivated them as they shared ideas. Learners need to learn from each other as well. It is necessary to define what is meant by gifted, especially when compared with 'bright' pupils. According to Muijs and Reynolds (2006:165) the term 'gifted' is usually used to refer to pupils who score significantly above average on ability tests.

Table 4.15 gives a comparison between a bright child and a gifted child, according to Muijs and Reynolds (2006:166):

Table 4.15: *Bright children versus gifted children*

Bright Child	Gifted Child
Knows the answer	Asks the questions
Interested	Extremely curious
Pays attention	Gets involved physically and mentally
Works hard	Plays around, but still gets good tests scores
Answers questions	Questions the answers
Enjoys same-age peers	Prefers adults or older children
Good at memorization	Good at guessing
Learns easily	Gets easily bored because s/he already knows the answers
Listens well	Shows strong feelings and opinions
Self-satisfied	Highly perfectionistic and self-critical

These types of learners should therefore be correctly handled in class including the average and slow learners. Accordingly, It is important to note that

Teaching gifted pupils in regular classrooms can lead to a number of problems. Such pupils are liable to find the content of lessons unchallenging and boring, and will not be stretched by the regular curriculum (Muijs & Reynolds, 2006:167).

A way of offering gifted pupils a more suitable education is through ability grouping. Another practice that has been posited as helpful to gifted pupils is co-operative learning (Muijs & Reynolds, 2006:168). The main advantage of using co-operative learning is that gifted learners can work as mentors to their less able learners, thus allowing them to take on responsible roles in class. This amplifies the importance of group work, particularly where mixed-ability students work together.

The empowerment of learners through hands-on exploration in the context of problem solving was also minimally done. It was reported that some learners struggled having to reason from problems to theory. Lack of resources also limited the respondents' ability to give learners a chance to explore. Indeed, hands-on exploration is difficult to achieve where there are no resources. The picture that emerged from the findings was that the respondents rarely allowed learners to conduct experiments on their own and arrive at conclusions by themselves. Furthermore, the respondents reported that a

lack of laboratory materials hindered educators to give learners a chance to do experiments, and that allowing learners to do experiments was time consuming due to big number of learners in classes. However, other educator respondents stated that allowing learners to conduct experiments on their own and arrive at conclusions by themselves encouraged learners to develop critical thinking skills, as well as manipulative skills. Further to this point, the respondents suggested that there should be laboratory assistants in schools to set up apparatus in the laboratory to save preparation time when learners are to conduct experiments.

The majority of the respondents reported that they always allowed learners to question, investigate and to seek out information in order to promote the development of their higher-order and critical thinking skills. The respondents further stated that this trained learners to develop reasoning skills as well, in addition to helping them to understand what was taught and to know how to work independently. They further felt that allowing learners to question investigate and to seek out information, helped learners to relate the concepts to other things happening in the world. They also indicated that this gave learners a sense of discovering and grasping of the concepts solidly.

A relatively high percentage of the respondents reported that they accommodated learners' prior knowledge and different learning rates. The respondents further stated that concepts were developed from what the

learners knew to what they did not know. This also helped educators to know what the learners knew and proceeded accordingly. Accommodating learners' prior knowledge and different learning rates makes learners to be confident. Moreover, the majority of the respondents reported that they encouraged learners to express their thoughts and ideas. They did this for self evaluation and criticism. Encouraging learners to express their thoughts and ideas assists an educator to find out learners' interest in his or her lesson and also make it possible for educators to give guidance. This way, learners feel they are part and parcel of the lesson.

Regarding the link between assessment and teaching and learning, one respondent stated that assessment was a tool to measure whether teaching-learning has taken place. He further stated that without assessment it is difficult to diagnose whether one has learnt anything. Therefore, in the view of this statement, assessment cannot be divorced from the teaching-learning endeavour. Another respondent indicated that assessment allowed the educator to know whether or not his/her approaches were good for the learners and is a kind of feedback from learners on the effectiveness of the teacher's instructional approaches.

4.5 ASSESSMENT STRATEGIES USED BY PHYSICAL SCIENCE EDUCATORS

Assessment is perceived as a process in which the educator determines what learners have learned (Satterly, 1981; Little, 1996). In an OBE system assessment is perceived as a process whereby learners' performance is assessed; that is, what it is that they can do in relation to what they are being taught (Gulting, 1997). As Jacobs, et al (2002:128) observe "assessment refer to the tasks set in order to obtain information about a learner's competence; assessment is guided by assessment criteria".

This study investigated the assessment strategies employed by educators and whether or not they were in line with OBE principles. This was in response to the third research question. Overall, respondents stated that they assessed learners continuously using a variety of strategies because they were not testing only knowledge but also assessing skills, values and attitudes. Strategies such as assignments, projects, oral presentations, and group work, homework, tests, examinations, research, creating models; etc; were among those that came from the respondents.

Table 4.16 shows the educators' responses as to how they implemented the Outcomes-Based Assessment (OBA) in schools. In the first column statement summarises are used to save space. They are stated in full below the table before the interpretation of the findings for each. The statements

include strategies, methods, tools and techniques of assessment as used by the educators.

Table 4.16 *The implementation of various OBA strategies (n=16).*

Assessment Method	Always	Regularly	Seldom	Never	TOTALS	%
Group Assessment	2 (13)	8 (50)	4 (25)	2 (13)	16	100
Peer Assessment	2 (13)	5 (31)	7 (44)	2 (13)	16	100
Self Assessment	3 (19)	6 (38)	5 (31)	2 (13)	16	100
Educator Assessment	9 (56)	4 (25)	2 (13)	1 (6)	16	100
Parent Assessment	1 (6)	3 (19)	5 (31)	7 (44)	16	100
Direct Observation	7 (44)	4 (25)	3 (19)	1 (6)	16	100
Journals	2 (13)	5 (31)	2 (13)	7 (44)	16	100
Assessment Grids/Rubrics	5 (31)	7 (44)	3 (19)	1 (6)	16	100
Class lists	9 (56)	4 (25)	2 (13)	1 (6)	16	100
Portfolios	8 (50)	4 (25)	2 (13)	2 (13)	16	100
Tests	9 (56)	4 (25)	2 (13)	1 (6)	16	100
Assignments	4 (25)	8 (50)	2 (13)	2 (13)	16	100
Demonstrations	2 (13)	6 (38)	5 (31)	3 (19)	16	100
Projects	5 (31)	7 (44)	3 (19)	1 (6)	16	100
Baseline Assessment	5 (31)	6 (38)	3 (19)	2 (13)	16	100
Summative	4 (25)	9 (56)	2 (13)	1 (6)	16	100
Normative Referenced	10(63)	3 (19)	2 (13)	1 (6)	16	100
Criterion Referenced	3 (19)	5 (31)	6 (38)	2 (13)	16	100
Diagnostic	1 (6)	3 (19)	5 (31)	7 (44)	16	100
Formative	1 (6)	2 (13)	3 (19)	10(63)	16	100

(Percentages are in brackets.)

Table 4.16 reveals the following information pertaining to educators' responses to each item:

Statement 1: I use group assessment methods in assessing the learners.

To this statement 13% of the educators reported that they **always** used group assessment methods and 50% did so **regularly**; 25% **seldom** did so; and 13% **never** used group assessment methods. This means the educators regularly used group assessment method in assessing learners' performance.

Statement 2: I use peer assessment methods in assessing the learners.

In this regard, 13% of the educator respondents reported that they **always** used peer assessment methods; 31% reported to do so **regularly**, 44% **seldom** used such methods; and 12% **never** did so. The majority response here was "seldom".

Statement 3: I use self assessment methods in assessing the learners.

With regard to the use of self-assessment, 19% of the educators reported that they **always** used self assessment methods; 38% reported to be doing so **regularly**; 31.25% **seldom** did so; and 13% **never** did so. It quite clear from this distribution that respondents were quite spread out across the various

options. Between **always** and **regularly**, we have a total of 57% and between **seldom** and **never**, a total of 44%

Statement 4: I use educator assessment method when assessing the learners.

In response to this, 56% of the educators indicated that they **always** used the educator assessment method; 25% stated that they did so **regularly**; 12% **seldom** used and 6% **never** used it. Overall, these results indicated that the **always** and **regularly** responses represented over three-quarters of the response heading. This is as one would have expected.

Statement 5: I use parent assessment method when assessing the learners.

With regard to the use of parent-related assessment methods, 6% of the educators indicated that they **always** used parent assessment methods; 19% did so **regularly**; 31% **seldom** used it and 44% **never** did so. The picture that emerges here is that the educators rarely involved parents in the assessment of their learners.

Statement 6: I use observation sheets or check lists as tools for recording learners' work.

In this regard, 44% of the educators reported that they **always** used observation sheets or check lists as tools for learner records; 31% did so **regularly**; 19% **seldom** used these tools and 6% **never** used them. This shows that there was a high rate of reported use of observation sheets and / or check lists as tools for recording the learners' work.

Statement 7: I use journals for recording learners' work

Reacting to this statement, 13% of the respondents indicated that they **always** used journals for recording learners' work; 31% reported to have done so **regularly**; 13% **seldom** used them and 44% **never** used them. It's clear from these percentages that the use of journals was minimally done.

Statement 8: I use assessment grids or rubrics for recording learners' work.

The response profile to this statement yielded 31% of the respondents as reporting that they **always** used assessment grids or rubrics; 44% used them **regularly**; 19% **seldom** used them and 6% **never** used them at all. The majority of the respondents fell between using the assessment grids or rubrics always and regularly for recording learners' work. This was a good result.

Statement 9: I use class lists for recording learners' work

A high number of educators (56%) reported **always** using class lists; 25% used them **regularly**; 13% **seldom** used them and 6% **never** used them. Again the majority of the educators either **always** used class lists for recording learners work, or they did so **regularly**.

Statement 10: I use portfolios for recording learners' work.

To this statement 50% of the educators reported that they **always** using portfolios for recording learners' work; 25% **regularly** used them; 13% **seldom** used them and 13% **never** used them. Here as well, the majority response fell under always and regularly.

Statement 11: I use tests when assessing learners' performance.

A relatively high number of educators (56%) **always** used tests in assessing learners' performance; 25% **regularly** used them; 13% **seldom** used them and 6% **never** used them. It is quite clear here also that the use of tests was quite popular and widespread among the educators comprising the research sample.

Statement 12: I use assignments when assessing learners' performance.

Regarding the use of assignments in the assessment of learner performance, 25% of the educator respondents reported that they **always** used assignments; 50% used them **regularly**; 13% **seldom** use them and 13% **never** use them. This shows also that, the use of assignments in the assessment of learners' performance was quite popular.

Statement 13: I use practical demonstrations when assessing learners' performance.

In responding to this statement, 13% of the educators reported that they **always** used practical demonstrations and 38% reported to do so **regularly**; about 31% **seldom** used them and 19% **never** used them. The breakdown between **always** and **regularly**, on one hand, versus **seldom** and **never**, on the other, was almost equally split.

Statement 14: I use projects when assessing learners' performance.

Concerning the use of projects in the assessment of learner performance, 31% of the educators indicated that they **always** used projects; 44% reported to **regularly** do so; 19% **seldom** used them and 6% **never** used them. This meant that, on average, the educators either **always** or **regularly** used projects in learner assessment. This is a very good result.

Statement 15: I use baseline assessment at the beginning of a new set of learning activities, in order to find out what learners already know.

The use of baseline assessment also followed a similar pattern as reported above. In this regard, 31% of the educators reported that they **always** used baseline assessment; 38% did so **regularly**; 19% **seldom** used baseline assessment and 13% **never** used it. This meant that, on the whole, the educators either always or regularly used baseline assessment at the beginning of a new set of learning activities, in order to find out what learners already knew. The combined **always** and **regularly** percentage came to 69%.

Statement 16: I use summative assessment in an overall report on the learners' performance.

To this statement, 56% of the educators reported that they **always** used summative assessment; 25% reported to be doing so **regularly**; 13% **seldom** did so and 6% **never** used it. This meant that the majority of the educators either **always** or **regularly** used summative assessment in an overall report on the learners' performance.

Statement 17: I compare learners' performance to that of other learners.

Reacting to this statement, 19% of the respondents indicated that they **always** compared learners' performance to that of other learners; 31% reported that they did so **regularly**; 38% **seldom** did so and 13% **never** did so. The distribution of responses on this item was about even between the **always** / **regularly** cluster vis-a-vis the **seldom** / **never**. It's important to remember that OBE emphasizes criterion-referenced assessment, much more than normative-referenced assessment. Learners' progress should be judged against the assessment criteria, rather than against classmates,

Statement 18: I compare learners' performance with the criteria he/she is expected to achieve.

In response to this, 31% of the educators indicated that they **always** compared learners' performance with the criteria he/she is expected to achieve; 44% stated that they did so **regularly**; 19% **seldom** did so and 6% **never** did so. The majority of educator respondents fell under the desired range or **always** and **regularly**. This is a good result.

Statement 19: I use diagnostic assessment to find out the nature and cause of a learner's learning difficulty.

In this regard, 25% of educators reported that they **always** used diagnostic assessment to find out the nature and cause of a learner's learning difficulty; 56% reported that they did so **regularly**; 13% **seldom** used diagnostic

assessment and 6% **never** used it. This meant that the majority of the educators (81%) either **always** or **regularly** used diagnostic assessment to find out the nature and cause of a learner's learning difficulty.

Statement 20: I use formative assessment to monitor and support learners' learning progress.

Concerning the use of formative assessment to monitor and support learners' learning progress, 19% of the educator respondents reported that they **always** used formative assessment; 63% reported that they did so **regularly**; 13% **seldom** did so and 6% **never** did so. This meant that the majority of the educators (82%) either **always** or **regularly** used formative assessment to monitor and support learners' learning progress.

Overall, it may be concluded from the above results that the educators differed in the extent to which they used the various assessment methods, tools and techniques. Generally speaking, most educators were not adequately using a variety of assessment methods, tools and techniques as required by the Outcomes-Based Assessment. The reason may be that they were not exposed to them.

Jacobs, et al (2002:280) stated that "summative assessment refers to the type of assessment which takes place at the end of a learning experience, and is

almost always norm referenced". This usually means a major test or examination, written at the end of a school year. Educators were used to summative assessment since it was traditionally used to promote the learner to the next grade. Summative assessment aims to find out how much of the learning outcomes, for the learning cycle, the learner has mastered. Jacobs, et al (2002:281) also describe formative assessment as assessment that "takes place during the learning process". They further state that "this type of assessment aims to inform the learning experience for each learner". In other words, formative assessment aims to help learners grow and progress.

Findings also reflected that some educators regularly used normative referenced assessment, that is, they compared learners' performance to that of other learners. However, the results also indicated that others regularly used criterion reference assessment, that is, they compared learners' performance with the criteria they are expected to achieve. Sieborger and Macintosh (1998:13) talk about "norm referencing and criterion referencing", as being the most common points of departure for educational assessment".

According to Jacobs, et al (2002:280),

A norm is a standard. When applied to assessment, norm referencing implies that the teacher assesses a learner's competence by comparing it to the competence of other learners (the norm). Traditionally this is done by means of class averages. Norm

referencing does not indicate what the learner has learnt, or what the learner has not yet learnt.

According to Jacobs, et al (2002:280), criterion referencing

Uses 'criteria' as reference points. Criteria are reference points against which other things can be assessed. But these criteria are specified beforehand and the learner is only assessed according to those criteria.

Jacobs, et al (2002:281) further maintain that "the important thing is to remember that all forms of assessment should be included in a teacher's assessment repertoire". Raggett (1994) expresses this in the following way, when he talks about the functions assessment fulfils in education:

Assessment may be formative, enabling a learner or teacher to check the progress against criteria; it may be diagnostic, enabling at least an initial identification of strengths and potential areas of learning difficulty, it may be used to provide guidance and feedback; it may be summative, providing a *grade which contributes to a final award*; and it may be the source of necessary external discipline without which a learner would fall too far behind in his other studies (Raggett, 1994).

4.6 PROFESSIONAL DEVELOPMENT OF EDUCATORS

The fourth research question focused on professional development as a possible vehicle through which the physical science educators would have been assisted in the implementation of the NCS. The following results relate to professional development, workshops attended by educators and professional development needs of educators.

4.6.1 Educators' Experience of Professional Development

Table 4.17 shows the models of professional development educators participated in since they started teaching.

Table 4.17 *Models of professional development (n=16).*

MODEL	0 Never	1 Once	2 Twice	3 Many	Total	%
Forma Courses	5 (31)	8 (50)	2 (12)	1 (6)	16	100
Short Courses	6 (38)	3 (19)	3 (19)	4 (25)	16	100
Workshops	2 (12)	2 (12)	7 (44)	5 (31)	16	100
Meeting & Seminars	10(62)	3 (19)	2 (12)	1 (6)	16	100
In-School Support	9 (56)	4 (25)	2 (12)	1 (6)	16	100
Conferences	11(69)	2 (12)	2 (12)	1 (6)	16	100

Table 4.17 reveals the following information pertaining to educators' responses to each item.

Statement 1: Formal courses leading to a degree or a diploma e.g. ACE, FDE.

Regarding this statement, 31% of educators never participated in professional development activities that led to a degree or a diploma; 50% participated once; 12% participated twice and 6% participated many times.

Statement 2: Short courses of two to three weeks duration that lead to a certificate, e.g. computer literacy certificate.

To this statement, 38% of educators reported that they never participated in short courses of two to three weeks duration that led to a certificate; 19% had participated once; 19% had participated twice and 25% many times. The majority response was that the educator respondents never participated in short courses of two to three weeks duration leading to the award of a certificate.

Statement 3: Workshop-based Training courses lasting longer than one day.

To this statement, 12% of educators reported that they never participated in workshops / training on assessment; 12% participated once; 44% twice and 31% had participated many times. This means that the majority of educator respondents participated in workshops / training on assessment twice.

Statement 4: Meetings, Presentations, Seminars (part of a full day) for example, talk by overseas visitor.

A high number of educators, 62% reported never having participated in meetings, presentations and seminars; 19% participated once; 12% twice; and 6% many times.

Statement 5: In-school support programmes, for example, projects where someone visits every week for six months.

To this statement, 56% of the educators reported never having participated in in-school support programmes; 25% had participated once; 12% twice and 6% many times. The majority response was that the respondents had never participated in in-school support programmes.

Statement 6: Conferences (lasting a few days) focusing on teaching (not union activity), e.g. KASTE, SAATPS, SAASTE, etc.

A high number of educators, 69% reported never having participated in conferences focusing on teaching; 25% had participated once; 12% twice; and 6% participated times. This means that the majority of the educators had never participated in conferences. Participation by the educators in workshops, training, conferences and seminars is to be encouraged.

4.6.2 Competence to Teach Physical Science in the FET Band

Table 4.18 shows the educators' responses with regard to their perceived competence to teach physical science in the FET band.

Table 4.18 *Perceived competence to teach Physical Science in the FET band by respondents (n=16).*

COMPETENCE	Frequency	%
VERY COMPETENT	05	31
COMPETENT	06	37
UNSURE OF COMPETENCE	03	19
LACK COMPETENCE	02	13
TOTAL	16	100

Table 4.18 indicates that 31% of the respondents that they were very competent, 37% competent, 19% unsure of their competence and 13% lacked

competence in some areas to teach physical science in the FET band. With OBE, the focus is on knowledge and how learners use the knowledge they have. Educators that lack competence and those that are unsure of their competence will tend to use the traditional approach in their teaching, learning and assessment practices.

4.6.3 Competence to Teach Learners Skills of Doing Investigations

Table 4.19 shows educators' responses with regard to their perceived competence to teach learners skills of doing investigations.

Table 4.19 *Perceived competence to teach learners skills of doing investigations (n=16).*

COMPETENCE	Frequency	%
VERY COMPETENT	04	25
COMPETENT	07	44
UNSURE OF COMPETE	03	19
LACK COMPETENCE	02	12
TOTAL	16	100

The above statistics show that 25% of the respondents thought that they were very competent, 44% competent, 19% unsure of their competence and 12% felt that they lacked competence to teach learners the "skills of doing

investigations”: Some respondents indicated that they did not do practical investigations. They suggested a workshop on practical work for educators.

4.6.4 Professional Development Needs of Educators

Table 4.20 shows the professional development needs of physical science educators. Educators were requested to indicate what they considered as their most important needs as well as their least important needs. The ranking of needs by the respondents was as shown in the table below:

Table 4.20 *Frequency distribution according to the ranking of professional development needs of educators (n=16).*

Professional development needs	Frequency	%
1. Development of physical science content knowledge.	2	12
2. Developing of pedagogical content knowledge.	2	12
3. Learning new methods of teaching.	1	6
4. Developing of management skills.	1	6
5. Improving the understanding of OBE and new curriculum.	4	25
6. Improving the understanding of CASS.	2	12
7. Learning new practical and investigation skills.	4	25
TOTALS	16	100

Table 4.20 reveals the following information about the professional development needs of the educators: 25% needed to learn new practical and investigation skills; another 25% needed to improve their understanding of OBE and the new curriculum; 12% needed to improve their understanding of

CASS; 12% needed to be developed in physical science content knowledge; and 12% needed to be developed in pedagogical content knowledge; 6% needed to learn new methods of teaching; and 6% needed to be improved in management skills.

More specifically, the respondents suggested the following professional developmental needs in the open-ended section of the questionnaire. They felt that attention to these issues would help them to improve on their daily practice:

- ✓ Improving the understanding of OBE and the new curriculum such as, discussing the purpose of the new curriculum and what changes it requires of teachers.
- ✓ To collaborate and meet with teachers within their schools and neighbouring schools in the district to discuss teaching science, with a view to acquiring many and different approaches of teaching science.
- ✓ To improve the understanding of CASS, such as, learning techniques of continuous assessment, for example, rubrics, etc, with a view to enabling educators to assess learners continuously as per requirements of OBE.
- ✓ Workshops on classroom discipline and management.
- ✓ A course on developing investigative and experimental skills in the classroom, in order to do investigative or experimental work that will allow learners to develop inductive thinking skills. Furthermore, the educators

wanted to learn new practical and investigation skills, such as the use of apparatus, doing investigations, practical demonstrations, etc. The educator respondents also wanted effective learning to take place in their classrooms, in order to ensure that learners felt a sense of achievement. It was the educators' wish to produce learners with critical thinking skills.

✓ Workshops that lead to "certificates of competence" recognised by the Department of Education were also favoured by the respondents. "This will allow educators to teach with confidence knowing that they have had proper up-to-date training in the FET phase", said one respondent.

✓ Interaction with other educators and seniors to allow them to develop professionally.

✓ Workshops and short courses on OBE, focusing on the FET band.

✓ Departmental guidelines need to be given to educators timeously, and need to be clear.

✓ Development of physical science content knowledge, e.g. improving understanding of electricity or cells or chemical reactions

✓ Science educators need workshops on new science topics in the FET band.

✓ Laboratory assistants were needed for in the FET schools to set up practical work.

✓ Developing pedagogical content knowledge, e.g., obtaining ideas on how to teach content, dealing with students' misconceptions, designing learning

programmes, designing rubrics, learning about using co-operative group work, using videos, concept maps, etc.

✓ One respondent added, “too many teachers do not know science but are teaching science therefore workshops are required at Circuit level”.

4.6.5 Best Activities to Improve Daily Teaching Practice

Most respondents suggested the following as the best activities to improve their daily practices:

- Registering for formal courses that lead to a degree for the following reasons:
 - To increase the knowledge and skills necessary to teach the new curriculum
 - To reinforce subject knowledge and give more confidence on subject matter.
 - To be more competent to present the lesson in a confident way and also to be better prepared for lessons.

One respondent added, “the system of education changes from time to time, therefore formal courses will help science educators to be in line with the changes that are taking place in education”.

- To attend in-service courses on topics such as lesson planning, etc.

- To attend training courses on content, presentation of lessons and practical work, as well as setting of tests and examination question papers.

To a large degree, these comments served as a further reinforcement of the professional development needs presented above.

4.6.6 Facilities and Resources for Physical Science Teaching and Learning

The following ten items are responses to questions regarding facilities and resources for teaching physical science. The data were collected and analysed as shown in Tables 4.18 to 4.24.

1. Did you receive any material during OBE training for physical science FET Band?

Table 4.21 shows educators' responses regarding material received during OBE training. The materials referred to here are those relating to Physical Science Assessment Guidelines (SAG), Learning Programme Guidelines (LPG), Content Document (CD) and the Subject (Physical Science) Policy Statement. Table 4.21 shows the response profile on the receipt of the above key materials.

Table 4.21 *Receipt of important instructional materials (n=16).*

Response Type	Frequency	%
YES	13	81
NO	3	19
TOTAL	16	100

The table indicates that 13 educators (81%) received the above teaching and learning materials during OBE training while 3 educators (19%) did not get the material at all because they did not attend the workshops. This is a good result. One would expect that when educators miss important training workshops, every effort is subsequently made to procure whatever materials were given out at the workshops.

2 Did you find the material useful in class?

Table 4.22 shows the educators' responses regarding the usefulness of the material received during OBE training.

Table 4.22 *The perceived usefulness of the material received (n=16).*

Response Type	Frequency	%
YES	13	81
NO	3	19
TOTALS	16	100

Table 4.22 indicates that 81% of the respondents who received the materials found them to be useful and working in class while 19%, that is, those who never received the materials reported that they did not find the material working in class. The materials referred to here were NCS documents, micro kits, for demonstrations by the educators.

3 Do you get help from the school management team (SMT)?

Table 4.23 shows the frequency distribution of educators on whether or not they received assistance from the school management.

Table 4.23 *Frequency distribution according to respondents receiving assistance from the management teams (n=16).*

Educators	Frequency	%
YES	11	69
NO	5	31
TOTALS	16	100

According to Table 4.20 69% of the respondents reported receiving help or support from the school management teams (SMTs), while 31% of the respondents reported not receiving such support from their SMTs. Some educators need assistance with transport money to attend OBE workshops. The lack of support may also be caused by poor management-educator

relationships. Formal and informal relationships with the SMT are not only important features of an educator's life, but may also have a considerable influence on OBE teaching and general behaviour in the classroom. The SMTs are responsible and accountable for the teaching and learning taking place in the classrooms.

4. How would you describe your school in terms of availability of resources for teaching?

Table 4.24 shows the educators' responses with regard to the availability of resources for teaching physical science. The resources in question included facilities like physical science laboratories, adequacy of classrooms, laboratory teaching and learning materials (apparatus) and books. Resources also included facilities like libraries and computer laboratories.

Table 4.24 *Availability of resources to teach physical science in the schools (n=16).*

SCHOOL	Frequency	%
NO RESOURCES	03	19
POORLY RESOURCED	09	56
ADEQUATELY RESOURCED	01	6
WELL RESOURCED	03	19
TOTAL	16	100

relationships. Formal and informal relationships with the SMT are not only important features of an educator's life, but may also have a considerable influence on OBE teaching and general behaviour in the classroom. The SMTs are responsible and accountable for the teaching and learning taking place in the classrooms.

4. How would you describe your school in terms of availability of resources for teaching?

Table 4.24 shows the educators' responses with regard to the availability of resources for teaching physical science. The resources in question included facilities like physical science laboratories, adequacy of classrooms, laboratory teaching and learning materials (apparatus) and books. Resources also included facilities like libraries and computer laboratories.

Table 4.24 *Availability of resources to teach physical science in the schools (n=16).*

SCHOOL	Frequency	%
NO RESOURCES	03	19
POORLY RESOURCED	09	56
ADEQUATELY RESOURCED	01	6
WELL RESOURCED	03	19
TOTAL	16	100

The above statistics show that more than half (56%) of the participating schools were reported to be poorly resourced, 6% were adequately resourced, 19% had no resources at all and 19% of the participating schools were well resourced. Thus, the table shows that the participating schools were resourced in varying degrees, with three (3) schools considered to be well resourced.

Extending the issue of resourcing, Table 4.25 summarises the data collected by the researcher during his visits to the participating schools.

Table 4.25 *The dimensions of the researcher’s observation instrument*

SCHOOL	FACILITIES					
	Physical Science laboratory	Classrooms	Laboratory Apparatus	Laboratory Equipment	Libraries	Computer Laboratory
A	√	√	√	√	√	√
B	√	√	√	√	√	√
C	√	√	X	X	√	X
D	√	√	X	X	X	X
E	√	√	√	√	√	√
F	X	√	X	X	X	X
G	√	√	X	X	X	X

During the course of data collection, the researcher observed that out of the seven (7) schools only three (3) schools had computer laboratories. This implied that learners completed matric from the rest of the schools not being computer literate. The researcher also observed that out of the seven (7) schools, four (4) schools did not have equipped libraries to refer learners for assignments and project tasks. Three (3) of the participating schools did not have library buildings at all. Some schools used science laboratories as classrooms for teaching all subjects, not only for physical science and practical work. This indicated, among other things, the shortage of classrooms in some schools. All the participating schools had classroom though in one school classrooms were not enough. There were big numbers in classrooms ranging from 60 to 70 learners per class. One school in Empangeni town added 5 prefabricated structures and 4 park homes to be used as classrooms. This school did not have a single science laboratory. Chemicals were kept in the administration block. This was dangerous to the lives of educators and administration staffs since they could, for example, inadvertently inhale poisonous gases. It is important that schools comply with safety procedures and guidelines relating to the handling of laboratory equipment and chemicals. The same school had no library and was using the staff room as a computer laboratory.

By way of comparing what the educators reported regarding the availability of resources with the observation schedule of what the researcher found, both

the researcher and the educators reported that schools were resourced in varying degrees. However, educators reported that three (3) schools had no teaching and learning resources at all; that more than half (56%) of the participating schools were poorly resourced while the researcher (from direct observations during school visits) found that of the seven (7) participating schools, four (4) schools were poorly resourced. There was not much mismatch between the information supplied by the educators' report and the researcher's findings through the observation schedule. This was one way of triangulation in the data collection process.

5. How often do you use these resources?

Table 4.26 shows the educators' responses with regard to the frequency of the use of resources.

Table4.26 *Frequency of resources utilization by respondents (n=16).*

RATE	Frequency	%
Once a month	07	43
Once a week	02	13
Daily	02	13
Other	05	31
Total	16	100

The above statistics show that 43% of the respondents used the indicated resources once a month. The resources referred to here were physical science and computer laboratories, computers, libraries, physical science laboratory equipment and classrooms. This implies that these respondents will end up using resources less than ten times in a year. In such schools, teaching, learning and assessment are likely not to be effective; 13% used the resources once a week and another 13% used the resources daily; 31% of the respondents indicated that they used resources twice a week and some used resources when there was a need.

One can assume that there is a great need for the government to supply as many resources as possible so that educators can achieve some of their objectives, that is, resources such as computers, physical science laboratory equipment and apparatus. This is important because appropriate and adequate learning resources have great potential to contribute towards positive learning experiences as they offer the individual learner an opportunity to develop to his/her full potential. Some educators indicated that they lacked skills of using some of the available resources. This implies that *educators also need training and re-skilling in the use of resources – thereby emphasising the need for on-going staff development.*

6. Are books, equipment and apparatus in good working condition?

Table 4.27 shows the educators' responses with regard to the condition of teaching and learning resources in schools.

Table 4.27 *The reported condition of resources in the schools (n=7).*

Condition of Resources (Lab. Equipment & Apparatus)	Frequency	%
Good	2	29
Not good	5	71
TOTAL	7	100

Table 4.27 indicates that 2 of the schools reported their resources to be in good condition, whereas 5 reported their schools as having resources that were not in good order. Some of the respondents in these schools stated that some of their laboratory chemicals had expired and other piece of equipment needed repair.

7. If not in good condition, why?

It was reported that the majority of schools were having vandalised laboratories. For schools with laboratories, it was also reported that:

- Chemicals had already reacted, old and hazardous.
- Equipment was old and needed to be replaced.

Respondents also indicated that resources were broken and mishandled when transported to schools, and also that there was a dire need to intensify a campaign on the supply of resources to effect OBE activities. Without adequate resources learning cannot be realised fruitfully. To provide educators with enough resources, such as books, laboratory equipment and apparatus, gives them overall ideas of the content and it ensures a proper balance.

8. Indicate the number of learners in the biggest class you teach.

Table 4.28 shows the educators' responses with regard to the number of learners in their biggest classes.

Table 4.28 *The number of learners in the biggest classes (n=16).*

Responses	Frequency	%
20 – 29	2	13
30 – 39	2	13
40 – 49	3	19
50 -59	4	25
60 – 69	5	31
TOTAL	16	100

Table 4.28 indicates that 31% of the educators had classes of more than 60 learners and 25% classes had more than 50 learners, 19% of the classes had

more than 40 learners; 13% had classes of more than 20 learners and also 13% had classes with between 30 and 39 learners.

9. What do you consider as a favourable educator-learner-ratio for successful teaching and learning using an OBE approach?

Table 4.26 shows the educators' responses as to what they considered as the favourable educator-learner-ratios.

Table 4.29 *Favourable educator-learner-ratios (n=16).*

Responses	Frequency	%
25 or less	2	13
30 or less	6	38
35 or less	3	19
40 or less	3	19
45 or less	2	13
TOTAL	16	100

Table 4.29 indicates that 38% thought that a class of not more than 30 learners represented a favourable educator-learner-ratio; 19% chose a class of not more than 35 learners; another 19% chose a class of not more than 40

learners; 13% chose a class of not more than 25 learners; and 13% chose a class of not more than 45 learners.

10. Give reasons for your response to question 9 above.

Most science educators preferred a class of 30 learners for successful teaching and learning. They gave the following reasons:

- Physical science requires individual attention. The large classes make it impossible to effectively implement OBE.
- Greater pupil-teacher interaction is possible in small classes.
- Control and discipline will be easier and the class is more manageable.
- Physical science requires hands-on practical work, therefore large classes create space problems, and groups tend to be too large for group work. Even demonstrations become unsuccessful and class control suffers during practical work. This leads to inefficient learning and no practical work done in the end.
- It is easy to finish marking fast for small classes and to give feedback to learners in good time.
- To determine whether teaching and learning is successfully taking place.

4.6.7 Summary of Professional Development of Educators

Findings revealed that physical science educators had participated in different models of professional development to varying degrees, however, some of

them had never participated in any professional development activities. About 50% of the educators reported having once participated in formal courses that led to a degree or diploma, while about 31% never participated in such courses; 25% reported having participated many times in short courses of two or three weeks duration that led to a certificate; and 38% never participated in such courses. A relatively high percentage (44%) of educators had participated twice in workshop training courses over more than one day and 13% of the educators never participated in such workshops. A high percentage (69%) of the educators had never participated in conferences that focused on teaching – such as these organised by the South African Association of Science and Technology Education (SAASTE). Indeed, a very low percentage (6%) of the educators had attended these conferences many times. De Waal (2004:63) maintains that “teachers are falling behind due to insufficient training and development”. Jacobs, Gawe and Vakalisa (2002:107) also make the following statement, in this regard:

There is a widespread feeling that teachers have not been properly prepared for OBE. It would appear that the knowledge base, concept understanding and general capacity of many teachers were below par before the introduction of OBE. Despite this situation, the new system has been imposed on them without well-constructed in-service teacher training programmes to support the new initiative.

Schreuder (1999:83), argues that "the effective implementation of curriculum presupposes clear understanding and preparation of the teacher". He further states that the effective implementation of a curriculum also "includes conceptual understanding, the availability of materials and ongoing support. It also presupposes good subject knowledge". In this vein, Christie states that "working with the principles of OBE required well-prepared teachers who are likely to be found in former Model C schools". It is said that teachers are struggling to come to grips as to what is really expected from them. Most of the classroom interaction is still dominated by talk and chalk (Vinjefold & Taylor, 1999:138).

This indicates that physical science educators need a strong motivation to upgrade their qualifications, to attend workshops and to affiliate to subject organisations like SAASTE, KASTE, SAATP, etc.

The professional development needs of educators were also investigated. Findings revealed that about 25% of the educators felt that they needed to learn practical investigation skills, that is, the use of apparatus, doing investigations, and practical demonstrations. Findings also reflected that about 25% of the educators needed to improve the understanding of OBE and the new curriculum; 13% needed to be developed in both physical science content knowledge and pedagogical content knowledge including obtaining ideas on how to teach content, student misconceptions and designing

learning programmes. Physical science educators also needed workshops on new topics that were introduced in the FET band as part of in physical science.

In response to the fourth research question, findings revealed the following as the professional development needs of physical science educators for the effective implementation of NCS:

- Workshops on the development of physical science content knowledge;
- Workshops on the development of pedagogical content knowledge;
- Workshops on class management skills;
- Workshops on physical science practical investigation skills; and
- Workshops that would help them improve the understanding of OBE, CASS and the new curriculum.

Physical science educators also needed facilities and resources for physical science teaching and learning, for example, classrooms, physical science laboratories, laboratory equipment and apparatus, libraries and computer laboratories. Furthermore, the findings revealed that physical science educators needed laboratory assistants to set up apparatus in the laboratory, in order to save time for teaching and learning.

4.7 CONCLUSION

This study looked at the role played by parents in supporting their children, instructional and assessment strategies used by physical science educators and their professional development needs. It was also found that most educators did not attend FET workshops to prepare them for 2006 in grade 10. Furthermore, the results showed that some educators did not get the necessary help from their management teams. The procurement of teaching and learning materials also presented serious challenges in some schools. A number of assessment methods, tools and techniques were in use, but more could be done. The results also pointed to a number of staff development needs for physical science educators. The next chapter focuses on the conclusions drawn from the study and also recommendations for both practice and possible further research.

CHAPTER FIVE

SAMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. SUMMARY

This study examined the challenges facing physical science educators in the implementation of the NCS in the Empangeni Education District. The nature and extent of grades 10 to 12 physical science Educators' understanding of assessment in the extent of an Outcomes-Based Education system was examined. The study also examined the nature of assessment forms and techniques used by educators at the school as well as the instructional strategies. The researcher also investigated whether these techniques were implemented in a manner that enhances learner performance. The researcher in Empangeni District schools also checked resources specific to OBE.

More specifically, therefore, the aim of this study was to assess the implementation of the NCS by physical science educators, in the various aspects of the requirement of the curriculum. In particular, the study sought to address the research objectives listed below:

- To determine the role played by parents in supporting their children in the implementation of the new curriculum;
- To find out the instructional strategies used by physical science educators, particularly where the necessary laboratory facilities and other attendant resources are absent or in short supply;

- To find out the assessment strategies, processes and procedures commonly used by physical science educators in the implementation of the NCS; and
- To determine the professional development needs of physical science educators.

The fieldwork undertaken involved the use of questionnaires for collecting data. The observational methods enabled the investigator to assume the role of both active participant and a privileged observer. The study was located within both the qualitative and quantitative research paradigms. It took the form of a case study involving seven (7) selected schools drawn from the Empangeni Education District.

Learners and educators were sampled from seven participating schools. Simple random sampling was used to determine the number of schools, educators and learners to participate in this study. Fifty percent (50%) of all learners doing grades 10 - 12 physical science per school were selected to participate in the study. A class list was used to select the number of learners, that is, 25% girls and 25% boys. Data required for this study were collected by posing questions to respondents using questionnaires for educators and learners as well as through direct observations. The data collected was captured in a format that permitted analysis and interpretation. This involved the careful coding of the 16 questionnaires completed by the educators, as

well as 320 questionnaires completed by grades 10 - 12 physical science learners. The information captured through direct observations was also appropriately categorised and classified.

5.2 MAJOR FINDINGS

A summary of findings is presented below under the sub-headings corresponding to the themes of the research objectives.

Parental Support and Involvement

Regarding parental support and involvement, the major findings were that (a) the majority of the learners lived with their parents, and (b) that they received support from home with regard to their academic work. It was also found that the majority of parents were working. However, a minority of the learners were not living with their parents and hence some of the learners did not get support from home with regard to their academic work.

Instructional Strategies Used by Physical Science Educators in Their Adaptation in the New Curriculum

With regard to instructional strategies employed by physical science educators, the major findings were that (a) the majority of the physical science educators regularly used the traditional instructional strategy (lecture method) to clarify or to introduce a new concept; (b) the engagement of learners in problem solving was minimally done; (c) the majority of educators were

dealing with large classes and therefore small groups were impossible; (d) the empowerment of learners through hands-on exploration in the context of problem solving was minimally done due to the following reasons:

- Some learners still struggled to reason problems from theory.
- Lack of resources limited giving learners a chance to explore.
- Hands-on exploration is impossible if there are no resources.

The majority of educators rarely allowed learners to conduct experiments on their own and arrive at conclusions by themselves since it took time to set up apparatus for learners to conduct experiments and therefore laboratory assistances were needed. Thus lack of laboratory materials hindered educators to give learners a chance to experiments. Moreover, allowing learners to do experiments was time consuming since educators were dealing with large classes hence the majority of the educator respondents rarely did practical demonstrations. The majority of educators always allowed learners to question, investigate and to seek out information in order to:

- Help their higher-order and critical thinking
- Train learners to develop reasoning skills.
- To train learners to work independently.
- To help learners to relate the concepts with the things happening in the world.

- To give learners a sense of discovering and grasping the concepts solidly.

The majority of the educators also accommodated learners' prior knowledge and different learning rates and always encouraged learners to express their thoughts and ideas. However, the use of instructional strategies by educator respondents depended on the type of the lesson and hence teaching methods were used in varying degrees.

Assessment Strategies Used By Physical Science Educators in Their Adaptation in the New Curriculum

The study also investigated the assessment strategies employed by science educators. The study also investigated whether physical science educators were in line with RNCS principles. The majority of the educator respondents regularly used the following assessment strategies when assessing the learners: (a) self assessment; (b) assessment grids, rubrics, checklists, and portfolios for recoding learners' work; (c) tests, research projects and practical demonstrations when assessing learners' performance; (d) compared learner's performance with the criteria he/she is expected to achieve; and (e) diagnostic assessment to find out the nature and cause of a learning difficulty. Findings also revealed that the physical science educators were assessing learners continuously using a variety of strategies because they were not testing only knowledge but also skills, values and attitudes. Fewer numbers used group assessment due to big numbers in classes. The picture that

emerged from the findings was that educator respondents rarely involved parents in the assessment of their learners. It was quite clear from the findings that the use of tests was quite popular and widespread among the educator respondents comprising the research sample.

Professional Development

Regarding educator professional development, the major findings were that the majority of the educator respondents indicated that they were in need of the following professional developments: (a) improving the understanding of CASS, OBE and the new curriculum; (b) workshops on classroom discipline; (c) a course on developing investigative and experimental skills; (d) development of physical science content knowledge; (e) developing pedagogical content knowledge, e.g., obtaining ideas on how to teach content, deal with students' misconceptions, design learning programmes and to design rubrics; and (f) laboratory assistances for the FET band to set up practical work. The majority of educator had never participated in in-school workshops and in short courses on NCS as well as in conferences focusing on teaching. Thus, the educator respondents were unsure of their competences to teach physical science in the FET band.

5.3 CONCLUSION

The research focused on the challenges facing physical science educators in the implementation of the NCS at Empangeni District. In spite of a number of problems and, difficulties experienced by the educators, overall, the majority displayed a positive attitude towards OBE, and were putting effort into understanding what OBE was all about. Nevertheless, a number of educators indicated that they lacked the necessary competences to teach learners certain skills – such as investigative skills. Some of them felt inadequately prepared to teach physical science in the FET band altogether. There were limited opportunities for in-service training and support from the Department of Education – such as teaching and learning materials, informative workshops, etc., that would help educators reflect on their implementation of NCS.

The researcher hopes that this research will contribute towards the changes that are taking place in the new education system. Further research and studies in this subject are therefore suggested.

5.4. RECOMMENDATIONS

The main findings of this study have been presented and discussed. The recommendations that follow draw from the engagement with literature and research findings, including participants' expressed concerns:

5.3.1 Parental support and involvement is essential in the education of their children but sometimes most parents believe their responsibilities to their children's education are limited to providing their children the basic needs of food, shelter, clothes, money, or places to study at home (Lee & Green, 2008:21). Many parents recognize the responsibility of educators and readily sign off their educational responsibilities. They also feel they are relieved when their children enter school. At home, parents should control time allowances for their children, make sure that their children complete assigned homework, and build a good rapport with their children. At school, parents should help to choose the right courses or educational streams for their children to study, join the school decision-making body to help make decisions to improve the school environment, and communicate with teachers to make sure that they are aware of the daily progression of their children. In the community, the parents should attempt to find extra resources to support their children's learning and expose them to future careers and/or educational opportunities (Lee & Green, 2008:21).

5.3.2 Parents sometimes do not become involved in their children's education because they feel they lack academic abilities and hence their involvement is not beneficial to their children's education. Therefore, the schools in Empangeni District or community organizations should work to develop substantive resources to help parents understand the importance of increased parental involvement and parental roles in relationship to their children's education (Lee & Green, 2008:23). In addition, the schools should also require parents to become more involved in parent and teacher conferences, especially at high school level. When more parents become involved in the education of their children, more students will have the resources and support to become successful in their education.

5.3.3 Professional teacher development should not be rushed. Thorough needs analysis must be done around the issue of quality of professional development programmes especially in rural areas as well as with regard to the type of support teachers really need.

5.3.4 There is a need to establish management systems at all levels, particularly in the circuits and districts in order to be able to support the CPTD programmes at school level. Such management systems could entail extensive human resources provision and capacity building.

5.3.5 The School Management Teams (SMTs) should be provided with training and continued support in order to be able to manage professional development activities.

5.3.6 Education Ministry should ensure maximum involvement of educators in the development and implementation of OBE. For policies such as OBE and NCS to succeed, it is imperative that teachers are fully involved in the development process of such policies. Educators have a good understanding of what goes on in classrooms and are on track with the mood and academic trends of the learners. De Waal (2006:77) also maintain that “educators have a first hand knowledge of learners and school environment and it is the teachers who can really give a true reflection of the day-to-day interactions in the schools”. Giroux (1998:125) also adds that “teachers should be involved in producing curricula materials suited to the cultural and social context in which they teach”.

5.3.7 Education Ministry should ensure that schools are well-resourced for the successful implementation of OBE. This includes facilities for teaching and learning, infrastructure such as physical science laboratories, laboratory equipment, enough classroom and furniture, libraries and computer laboratories. Findings revealed that educators did not receive the necessary support and lacked appropriate resources. The lack of resources should be addressed in a radical manner. Imend (2002:30) states that

educational reform and curriculum change are an expensive business which cannot succeed if there is no deliberate resource outlay dedicated to their success – particularly in a situation that OBE finds itself as an innovation initiated by the government.

He believes that it is the government's responsibility to

make available funding and other resources for physical and other infrastructural requirements, as well as enabling facilities which would make the actualisation of OBE possible at the 'classroom' level (Imenda, 2002:30).

De Waal (2006:79) also suggests that "the Education Ministry must work in conjunction with the private sector on strategies to assist schools in acquiring resources". The resources to be provided should be the ones that are best suited for the needs of learners. Resources should be accessible and easy to understand.

5.3.8 The Department of Education should ensure an ongoing training and support to physical science subject advisors and educators as implementers of the curriculum. The curriculum needs strong monitoring by the subject experts and the subject advisors. The Department of Education should increase the number of subject advisors to monitor educators work at least quarterly and to check the progress. Training should begin with subject

advisors on how to implement assessment in OBE and/or NCS since some of them may not have the knowledge and competence to implement assessment in OBE. After the training of subject advisors, the next step should be that of training the subject (physical science) educators. This can be done in the form of workshops. The training should be more practical than just a theory. Practical examples, using educators' background knowledge of the subject is essential. Workshops must be embedded with quality and not quantity. Information given to educators must be clear. De Waal (2006:81) maintains that "teachers should not feel lost when they are at school". He further suggests that "support groups must be within reach and assist". Workshops before and after implementation are necessary for reviewing and reflection of practices.

5.3.9 Educators who were involved in training should form a nucleus of leadership for other educators within schools, wards, circuits, districts and provinces. They should actively participate in helping other educators to implement assessment in OBE. Educators must be encouraged to initiate cluster groups as from grade 10 to communicate and collectively master and understand the new curriculum. They can hold discussions, reflect on classroom pedagogy and scrutinize about which resources are needed or best suited for certain learning experiences. They must be encouraged to forward their recommendations to advisory services and further to the Education Ministry as one way of involving educators in the implementation of the new curriculum. If there are more than one educator teaching physical

science in the same school and teaching the same (FET) band, they should be encouraged to have their regular subject committee meetings or workshops. Subject committee meetings will serve as a forum for sharing ideas regarding the implementation of the outcomes-based assessment.

5.3.10 The Superintendents of Education Management (SEMs) and Examination Services should continuously train and develop principals in order to sustain their roles as leaders and motivators. Heads of Departments (H.O.Ds) as members of the School Management Teams (SMTs) should also be trained to give guidance and leadership in as far as the implementation of the new curriculum and outcomes-based assessment is concerned. Educators are uncertain in their practice of OBE due to a lack of adequate support from the school management. To ensure that principals are confident and capable to perform their duties and effectively lead their staff, continuous support and monitoring is imperative.

5.3.11 A plan should be in place to provide an on-going monitoring and support to educators. Monitoring and support go hand in hand in the sense that it is through monitoring that one can identify areas which need support and development. The continuous monitoring and support should lead to evaluation stage. This is where deficiencies or problems in the implementation of assessment in the new curriculum are identified and analysed in order to determine alternatives or find appropriate interventions.

Evaluation is not the final stage of the implementation process because if deficiencies or problems are identified, more support and monitoring should be provided to educators.

5.3.12 Where group work is impossible due to large class, pair work could be used as a way of improvising. A learner should work with another learner sitting next to her or him. It is also recommended that group work be more suited to application or practice of knowledge already learned than to learning of entirely new concepts.

5.3.13 Learning material for the learners should be well provided. This would encourage active learning and full participation by all learners. The implementations of OBE and utilization of resources should be coupled with motivating learners to read extensively. Resources used; the emphases should fall on encouraging same thinking skills. Where OBE resources are used; the emphasis should fall on encouraging some thinking skills.

5.3.14 Partnership with people should be encouraged, so that schools can get resources. Educators should also be encouraged to network with other schools. There must be team teaching taking place in school more, especially when grade 10 classes are taught by more than one science educators.

5.3.15 The researcher found that same learners do not receive help from their parents at home with respect to assessment. Parents as stakeholders in school are expected to play a meaningful role in their children's learning. Robison's (1995; 298) cited in Goodwin, (1997) state that parents admit to having limited knowledge on curriculum issues and on how to assess learning. Educators are also aware of the parents' illiteracy and yet appeared to have high expectation of the parents to give meaningful and effective feedback. The school should have programmes to develop parents' skills and knowledge in this regard.

5.3.16 The school can play a major role in alleviating parents' illiteracy through workshop. In these workshop educators needs to workshop parents on the South Africa schools act of 1996 so that they become well versed in issues of governance, professionals, curriculum and assessment and the role that parents' need to play at school. Wood,(1988) holds that a sound working relationship is necessary to promote parents professional communication

5.3.17 The school also needs to workshop parents and the governing body structure on transformational policies, curriculum issues and assessment in order to ensure maximum participation by parents' in their children learning. In this study, learners in their responses indicated that their parents' help them to understand better which mean that parents can be used as resources for their children. With these workshops in places, parents will have

information on how to participate in their children learning and also enable parents to give effective feedback to educators. Torrance (1995; 72) states that parents who learn the why's and how's of assessment prior to and during implementation can provide the support necessary to sustain effective learning.

5.3.18 The environmental factors in rural areas may have a negative impact on the academic performance of learners since they are not exposed to some of the things that are in the curriculum. As it was mentioned early, some schools do not have science laboratories, computer laboratories and libraries. The curriculum planners or designers should ensure that this new curriculum caters for both schools in urban and rural areas. They must strike a balance. Subject choices should be wide for both the learners in rural and urban area. The fact remain that the curriculum is new and everybody is exploring.

5.3.19 There is also a need for all educators to be trained as qualified and registered assessors. The Department of Education should have a budget for the training of educators to be qualified assessors.

5.3.20 Outcomes-based Education as a new system needs skilled and well-educated educators. If the educators run short of these skills, our education will reach a crisis characterised by non-delivery. Lack of suitably qualified educators in African schools and rural areas has led to what is describe as

“an unfortunate cycle” by which poorly educated person enter teaching and in turn produce poorly educated students. To improve this, the department of education should promote the personal growth of educators in the form of staff development programmes. This may be done in the form of weekend course or workshops presented at training institutions

5.3.21 Educational resources are expensive, but can last long time if treated and handled properly. One of the key areas of the principals as organizational managers is to make sure, through correct policy and procedures, that pupils are taught how to handle resources properly. Principals as heads of the institutions must make sure that offices, classrooms, storerooms and other rooms are locked when not in use. Management, care and utilization of resources are therefore essential to ensure that the school maximises and mobilizes its resources to the full and complete benefit of its clients the pupils and the community.

5.3.22 There is a need for care and proper handling of resources. One of the reasons might be that resources are not cared for and also not handled properly. Educational resources are expensive, but can last a long time if treated and handled properly. One of the key task areas of the principals as organisational manager is to make sure, through correct policy and procedure, that pupils are taught how to handle resources properly.

However in order to prevent misuse of resources, misappropriation, neglect, destruction, vandalism, theft and mishandling, the principal as the head of the institution must make sure that offices, classrooms, store rooms and other rooms are locked when not in use.

The principal must still undertake regular and careful resource control steps to ensure that policies and procedures in this regard are being carried out. All state property must be marked with indelible letters. The requisition for school furniture must be submitted to the circuit or district office. Resources like furniture, equipment, apparatus, video machines, television, computers, fax machines, photocopiers etc, should be properly cared for in good order.

Loss of the state property through theft, fire or any form of fraud must be reported to the police immediately. All available information must be given to the police and all such incidents must be reported to the circuit, or district office managers at the earliest possible opportunity. State resources may not be sold by the school unless permission has been obtained from the educational department, and arrangements for pricing and payment of money accrued from such sales determined.

5.3.23 Pupils should not be allowed into stock rooms unless under the supervision of a responsible adult. It is vitally important that the principals as school managers keep a firm hand on the control of educational resources in

the school. The final accountability for the lost or stolen resources cannot be delegated. Principals must inspect all stock registers regularly and without warnings thus making sure that are always kept up to date. Proper control is a key aspect in the in the management of resources.

5.3.25 Faculty of education at universities should be requested to assist educators on an ongoing basis through formal in-service courses as one way of partnership with Education Ministry.

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APPENDIX A

QUESTIONNAIRE TO GRADES 10-12 PHYSICAL SCIENCE EDUCATORS.

SECTION A.

1. Biographical Data

When given a choice, mark your response by placing a cross in the appropriate block. Otherwise, indicate your response in the space provided.

SEX

MALE	
FEMALE	

AGE IN YEARS

UNDER 30	
30-39	
40-49	
50-59	
60+	

PHYSICAL SCIENCE TEACHING EXPERIENCE IN YEARS

0-5 YEARS	
6-10 YEARS	
11-15 YEARS	
16-20 YEARS	
20+ YEARS	

1.4. TYPE OF SCHOOL TEACHING AT

PRIVATE SCHOOL		GOVERNMENT SCHOOL	
----------------	--	-------------------	--

1.5. POST LEVEL

PRINCIPAL	
DEPUTY PRINCIPAL	
HEAD OF DEPARTMENT	
EDUCATOR	

1.6. POST HELD

PERMANENT		TEMPORARY	
-----------	--	-----------	--

1.7. ARE YOU EMPLOYED BY

DEPARTMENT OF EDUCATION?		THE GOVERNING BODY?	
--------------------------	--	---------------------	--

SECTION B

2. Instructional Approaches and Educator Implementation of CASS.

Please indicate how frequently you use each of the following instructional approaches and give a brief comment in the space provided to substantiate your responses.

Use the keys given below to indicate your response for each item statement.

KEY : ALW.-----ALWAYS
 REG.-----REGULARLY
 SOM.-----SOMETIMES
 NEV.-----NEVER

ITEM NO.	STATEMENT	ALW.	REG.	SOM.	NEV.
1.	I use lecture/telling method to clarify a concept. Comment: _____ _____				
2.	I engage learners to problem solving as small groups. Comment: _____ _____				
3.	I use direct instruction (explanations) to help learners acquire factual knowledge. Comment: _____ _____				
4.	I empower learners through hands-on exploration (manipulative skill development) in the context of science problem solving. Comment: _____ _____				
5.	I allow learners to conduct experiments (resource tasks) on their own and arrive at conclusions by themselves (discovery learning). Comment: _____ _____				
6.	In case of experiments, I do demonstrations and then allow learners to practice the skill for				

	themselves under my supervision. Comment: _____ _____				
7.	I allow learners to question, investigate and seek out information in order to help their higher-order and critical thinking skills. Comment: _____ _____				
8.	I accommodate learners' level of prior knowledge and different learning rate. Comment: _____ _____				
9.	I encourage learners to express their own thoughts and ideas. Comment: _____ _____				
10.	I base instruction on mastery of skills an/or concepts. Comment: _____ _____				

11. What would you consider to be the link between assessment and instructional (teaching/learning) approaches?

12. In practice, how do you relate assessment to your instructional approaches?

13. Are there any comments you would like to make regarding this topic?

SECTION C

3. Facilities and Resources

3.1 Did you receive any material during OBE training for Physical Sciences FET band?

YES

☐

NO

☐

3.2 Do you find the equipment and material useful in class?

YES

☐

NO

☐

3.3 Do you get help from the management?

YES

☐

NO

☐

3.4 How would you describe your school in terms of availability of resources for teaching Science?

No resources for teaching		Poorly resourced		Adequately resources		Well resourced	
---------------------------	--	------------------	--	----------------------	--	----------------	--

3.5 How often do you use the resources?

Once a week		Once a month		Daily		Other	
-------------	--	--------------	--	-------	--	-------	--

3.6 Are they in good working condition?

YES

☐

NO

☐

3.7 If not. Why?

SECTION D

4. Assessment Strategies and Educators Implementation of Cass

Please indicate how frequently do you use each of the item statements listed below.

Use the rating scales given to write your rating number for each item statement in the box at the end of each item statement.

Always	Regularly	Sometimes	Never
3	2	1	0

ITEM No.	STATEMENT	RATING
1	I use group assessment method when assessing the learners.	
2	I use peer assessment method when assessing the learners.	
3	I use self assessment method when assessing the learners.	
4	I use educator assessment when assessing the learners.	
5	I use parent assessment method when assessing the learner.	
6	I use observation sheets or check list tool for recording learners' work.	
7	I use journals for recording learners' work.	
8	I use assessment grids or rubrics for recording learners' work.	
9	I use class lists for recording learners' work.	
10	I use portfolios for recording learners' work.	
11	I use baseline assessment at the beginning of a new set of learners' activities, in order to find out what learners already know.	
12	I use summative assessment in an overall report on the learners' performance.	
13	I compare learners' performance to that of other learners	
14	I compare learners' performance with the criteria he/she is expected to achieve.	
15	I use diagnostic assessment to find out the nature and cause of a learner's learning difficulty.	
16	I use formative assessment to monitor and support learners' learning progress.	
17	I use tests when assessing learners' performance.	
18	I use assignments when assessing learners' performance.	
19	I use practical demonstrations when assessing learners' performance.	
20	I use projects when assessing learners' performance.	

SECTION E

5. Professional Development of Educators

5.1 QUALIFICATION OF RESPONDENTS

ACADEMIC QUALIFICATIONS (e.g. B.A., B.Ed., etc.)	
PROFESSIONAL QUALIFICATIONS (e.g. HED, UED, etc.)	

5.2 MODELS OF PROFESSIONAL DEVELOPMENT

What models of professional development have you participated in since you started teaching?

Please tick in the relevant columns to show how often you have participated in these INSET activities. (0=never attended, 1=only once, 2=twice, 3=more than two times)

What have you participated in?	0 Never	1 once	2 Twice	3 many
1 Formal courses that lead to a degree or a diploma e.g. ACE, FDE, etc.				
2 Short courses of two or three weeks duration that lead to a certificate.				
3 Workshops Training course over more than one day e.g. 3 days on assessment.				
4 Meetings, Presentations, Seminars (part of a full day) e.g. talk by overseas visitor				
5 In-school support programmes e.g. project where someone visits every week for six months.				
6 Conferences (lasting a few days) Focusing on teaching (not on union activity)				
7 Any other? Please specify: _____				

5.3 How competent do you consider yourself to teach Physical Sciences in FET band?

Very Competent		Competent		Unsure Of My Competence		I Lack Competence In Some Skills	
----------------	--	-----------	--	-------------------------	--	----------------------------------	--

5.4 How competent do you consider yourself to teach learners the skills of doing investigations?

Very Competent		Competent		Unsure Of My Competence		I Lack Competence In Some Areas	
----------------	--	-----------	--	-------------------------	--	---------------------------------	--

5.5 RANKING OF NEEDS

Please rank your professional development needs in relation to each other.

(If you have no needs at all then leave this table blank)

Allocate 1 to what you consider as your first need, 2 to what you consider as your second need etc and 7 to what you consider as your last or least important professional development need.

PROFESSIONAL DEVELOPMENT NEEDS	Rank in order of most important need (1) to least important need (7)
1. Development of content knowledge Eg. Improving understanding of electricity or cells or chemical reactions	
2. Developing of pedagogical content knowledge. Eg. Obtaining ideas on how to teach content, student misconceptions, designing learning programme etc	
3. Learning new methods of teaching Eg. Learning about using cooperative group work, using video, concept mapping etc.	
4. Developing of management skills Eg. How to improve classroom discipline and management, planning the teaching programme etc.	
5. Improving the understanding of OBE and new curriculum. Eg. Discussing the purpose of the new curriculum, what change it requires of teachers.	
5. Improving the understanding of CASS Eg. Learning techniques of continuous assessment such as rubrics, etc	
7. Learning new practical and investigation skills Eg. Use of apparatus, doing investigations, practical demonstrations etc.	

5.6 Best Activity: What kind of professional development would you choose to attend if you were offered all facilities and necessary funds, including leave from school, to improve your own daily teaching practice in your present school?

5.7 Reason: Why would this make a difference to your daily teaching practice

Thank you for your time!

APPENDIX B

LEARNER QUESTIONNAIRE (GRADES 10 – 12)

The aim of the questionnaire is to assess the understanding of the purpose of assessment by learners and the implementation of the assessment strategies in teaching- learning situations. It would be helpful and appreciated if you fill this questionnaire sincerely.

INSTRUCTIONS:

Please check with (X) in the appropriate box.

In case of open-ended questions, write in the space provided.

Do not write your name. All details are confidential.

1. GENDER

Male	
Female	

2. AGE

Under 15 Years	
15 Years	
16 Years	
Older than 16 Years	

3. Do you live with?

Both PARENT	
Father Only	
Mother Only	
Other (Specify)	

4. What do your parents do for a living?

Unemployed	
Self-Employed	
Employed	
Other (Specify)	

5. How often are you assessed at school?

Quarterly	
Monthly	
Weekly	
Regularly (Specify)	

6. Which assessment strategies (methods/ forms of assessment) are used when you are being assessed?

7. Of the assessment strategies mentioned above, which ones are mostly used?

8. Would you say that the discussions you have had with your teachers helped with learning and your performance?

YES

☐

NO

☐

EXPLAIN

9. Would you say that the help you received from your parents has helped, improved your learning and your performance?

YES

☐

NO

☐

EXPLAIN

THANK YOU FOR YOUR TIME!!

APPENDIX C

OBSERVATION SCHEDULE: CHECKLIST

NAME OF SCHOOL: _____

NO	ITEM	YES	NO
1	CLASSROOM		
1.1	Classroom spacious		
1.2	Adequate seating (Furniture)		
1.3	Teaching aids visible		
1.4	Learners physically accessibility		
1.5	Overcrowded		
1.6	Fit for classroom practice		
2	LABORATORIES		
2.1	Physical Sciences Laboratory		
2.2	Life Sciences laboratory		
2.3	Laboratory Equipment		
2.4	Laboratory Apparatus		
2.5	Computer Laboratory		
2.6	Computers		
3	LIBRARY		
3.1	Library Contents (Books and other materials)		
4	Learning Materials		
4.1	Text Books or Reference Books		
4.2	Stationery		
5	POLICIES AND DOCUMENT		
5.1	School Policy		
5.2	Science Department Policy		
5.3	Physical Science NCS Document		
5.4	Physical Science Subject Assessment Guidelines (SAG)		
5.5	Physical Science Learning Programme Guidelines (LPG)		
5.6	Physical Science Subject Framework (Band Planning)		
5.7	Physical Science Work schedule (Grade Planning)		
5.8	Lesson Plan		
5.9	Educator's Portfolio		
5.10	Learners' Portfolios		

APPENDIX D

PO Box 2047
EMPANGENI
3880

22 January 2007

EMPANGENI EDUCATION DISTRICT MANAGER

Dear Sir / Madam

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am presently registered for an M.Ed Degree in the faculty of education at the university of Zululand.

I am conducting a research study entitled: "Challenges Facing Physical Science Educators in the Implementation of NCS. A Case of Empangeni Education District."

I am requesting access to some of the schools in your circuit, in order to carry out an investigation regarding the above-mentioned topic. I wish to administer a questionnaire to grade 10 - 12 Physical Sciences Educators and Learners from schools selected randomly in the your circuit.

You are assured that the study will not in any way interfere with the normal running of the school. Teachers will be requested to complete the questionnaire at home.

A copy of the questionnaire is attached. I hope it meets your approval. The names of the schools and educators will be strictly treated as confidential, but the findings of this research can be forwarded to your office should you wish so.

Your permission to conduct research in this circuit will be highly appreciated.

Yours faithfully

S P Mchunu (Mr)

APPENDIX E

PO Box 2047
EMPANGENI
3880

22 January 2007

THE CIRCUIT MANAGER

Dear Sir

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am presently registered for an M.Ed Degree in the faculty of education at the university of Zululand.

I am conducting a research study entitled: "Challenges Facing Physical Science Educators in the Implementation of NCS. A Case of Empangeni Education District."

I am requesting access to some of the schools in your circuit, in order to carry out an investigation regarding the above-mentioned topic. I wish to administer a questionnaire to grade 10 - 12 Physical Sciences Educators and Learners from schools selected randomly in the your circuit.

You are assured that the study will not in any way interfere with the normal running of the school. Teachers will be requested to complete the questionnaire at home.

A copy of the questionnaire is attached. I hope it meets your approval. The names of the schools and educators will be strictly treated as confidential, but the findings of this research can be forwarded to

your office should you wish so.

Your permission to conduct research in this circuit will be highly appreciated.

Yours faithfully

S P Mchunu (Mr)

APPENDIX F

P O Box 2047
EMPANGENI
3880

22 January 2007

THE WARD MANAGER

DEAR Sir

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am presently registered for a M,Ed Degree in the faculty of education at the university of Zululand. I am conducting a research study entitled: "Challenges Facing Physical Science Educators in the Implementation of the NCS. A Case of Empangeni Education District".

I am requesting access to some of the schools in your ward, in order to carry out an investigation regarding the above-mentioned topic. I wish to administer a questionnaire to grade 10 -12 Physical Sciences Educators and Learners from schools selected randomly.

You are assured that the study will not in any way interfere with the normal running of the school. Teachers will be requested to complete the questionnaire at home.

A copy of the questionnaire is attached. I hope it meets your approval. The names of the schools and educators will be strictly treated as confidential, but the findings of this research can be forwarded to your office should you wish so.

Your permission to conduct research in this ward will be highly appreciated.

Yours faithfully

S P Mchunu (Mr)

APPENDIX G

P.O BOX 2047
EMPANGENI
3880

22 January-2007

THE PRINCIPAL

DEAR Sir

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am presently registered for a M.Ed Degree in the faculty of education at the university of Zululand. I am conducting a research study entitled: "Challenges Facing Physical Science Educators in the Implementation of the NCS. A Case of Empangeni Education District"

I hereby seek your permission to administer a questionnaire to Physical Sciences Educators and grade 10 Physical Science learners. A copy of a questionnaire is attached. I hope it meets your approval.

The information to be obtained will be strictly treated as confidential and will be used for the benefit of the school. You are also assured that the study will not in any way interfere with the normal running of the school. Educators will be requested to complete the questionnaire at home.

I hope this study will make a meaningful contribution towards the Outcomes-Based Education Assessment in the FET band especially in Physical Science.

Your permission to conduct research in this school will be highly appreciated.

In anticipation, thank you for your kind consideration.

Yours faithfully

S. P. Mchunu (Mr)

APPENDIX H

PO BOX 2047
EMPANGENI
3880

22 January 2007

THE RESPONDENT

DEAR Sir/Madam

RE: QUESTIONNAIRE ON OUTCOMES-BASED ASSESSMENT.

At present I am engaged in a Research Project towards my Master of Education Degree at the University of Zululand under the supervision of Prof. SN Imenda and Mr MS Ntuli. The research is focused on the challenges facing physical science educators in the implementation of the NCS. A case of Empangeni Education District.

I have taken the liberty of writing to you in order to seek your assistance in acquiring information about your experience relating to this research.

All information will be regarded as confidential and no personal details will be mentioned in the findings, nor will any of the results be related to any particular school.

In anticipation, thank you for your kind consideration.

Yours faithfully

S. P. Mchunu (Mr)



PROVINCE OF KWAZULU-NATAL
ISIFUNDAZWE SAKWAZULU-NATALI
PROVINSIE KWAZULU-NATAL

DEPARTMENT OF EDUCATION
UMNYANGO WEMFUNDO
DEPARTEMENT VAN ONDERWYS

Telephone: 035 9018700
Fax: 035 7722138

Private Bag X 14
Empangeni Rail
3910

21 Union Street
EMPANGENI
3880

LOWER UMFOLOZI CIRCUIT

Inquiries:
nibuzo: V O MHLUNGU
lavrae:

Reference:
Inkomba:
Verwysing:

Date:
Usuku: 16 February 2006
Datum

Mr. S P Mchunu
Old Mill Senior Secondary School
P O Box
Empangeni
3880

**PERMISSION TO CONDUCT RESEARCH FOR M ED DEGREE IN NGWELEZANE
WARD**

I have received your correspondence dated 18 January 2006 in which you requested for permission to conduct a study in some of the schools in the Ward.

As an office we have no objection to this request, instead we fully support the wonderful work you are doing as it will add to the valuable knowledge we need to improve education in our communities.

Please accept my apology for such a late response, hoping it has not caused much inconvenience.

Signed. 

Date. 16/02/2006

Ward Manager



PROVINCE OF KWAZULU-NATAL
ISIFUNDAZWE SAKWAZULU-NATALI
PROVINSIE KWAZULU-NATAL

DEPARTMENT OF EDUCATION
UMNYANGO WEMFUNDO
DEPARTEMENT VAN ONDERWYS

Telephone : 035 9018700
Fax : 035 7722138

Private Bag X 14
Empangeni Rail
3910

21 Union Street
EMPANGENI
3880

LOWER UNFOLOZI CIRCUIT

Enquiries:
mibuzo: Dr V.E. Sikhosana
Navrae:

Reference:
Inkomba: Research in R/Bay Sch
Verwysing:

Date:
Usuku: 22 June 2006
Datum

Mr S. P. Mchunu
P.O. BOX 2047
EMPANGENI
3880

RE: PERMISSION TO CONDUCT RESEARCH STUDY

1. The matter as mentioned supra has reference.
2. You are hereby given permission to conduct the research study in the schools that belong to Richards Bay Ward.
3. Kindly ensure that you communicate with the affected school principals in advance.
4. Best wishes for your research and hoping that it will inevitably add value to your existing quality of education for the benefit of the nation.


WARD MANAGER
RICHARDS BAY

22/06/06
DATE



PROVINCE OF KWAZULU-NATAL
ISIFUNDAZWE SAKWAZULU-NATALI
PROVINSIE KWAZULU-NATAL

DEPARTMENT OF EDUCATION
UMNYANGO WEMFUNDO
DEPARTEMENT VAN ONDERWYS

Telephone : 035 9018700
Fax : 035 7722138

Private Bag X 14
Empangeni Rail
3910

21 Union Street
EMPANGENI
3880

LOWER UMFOLOZI CIRCUIT

Enquiries:
mibuzo: Mr S. Ngema
Iavrae:

Reference:
Inkomba: Research
Verwysing:

Date:
Usuku: 20 January 2006
Datum

Mr. S.P. Mchunu
P.O. Box 2047
Empangeni
3880

Sir

PERMISSION TO CONDUCT RESEARCH IN THE KWAMBONAMBI WARD SCHOOLS.

Your letter dated 18 January 2006 in respect of the above subject refers.

Kindly be informed that permission is hereby granted to you to conduct your research.
Please note the following:

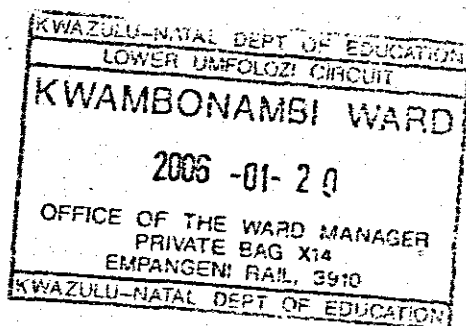
1. Schools will participate on a voluntary basis.
2. Teaching and learning activities will not be disturbed.
3. Access to school will have to be negotiated with the principals.
4. Report to the Ward Manager- Kwambonambi Ward on completion of your Project.

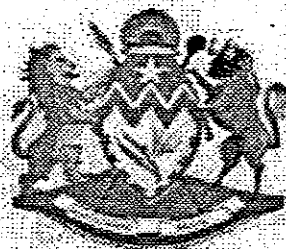
I wish you all the success in your undertaking

Thank you.

S. Ngema

S. Ngema : Kwambonambi Ward Manager.





PROVINCE OF KWAZULU-NATAL
ISIFUNDAZWE SAKWAZULU-NATALI
PROVINSIE KWAZULU-NATAL

DEPARTMENT OF EDUCATION
UMNYANGO WEMFUNDO
DEPARTEMENT VAN ONDERWYS

Telephone : 035 9018700
Fax : 035 7722138

Private Bag X 14
Empangeni Rail
3910

21 Union Street
EMPANGENI
3880

LOWER UMFOLOZI CIRCUIT

Enquiries:
Imibuzo: Mr S. Ngema
Navrae:

Reference:
Inkomba : Research
Verwysing :

Date:
Usuku : 25 January 2007
Datum

Mr. S.P. Mchunu
P.O. Box 2047
Empangeni
3880

Sir

PERMISSION TO CONDUCT RESEARCH IN THE LOWER UMFOLOZI CIRCUIT SCHOOLS.

Your letter dated 22 January 2007 in respect of the above subject refers.

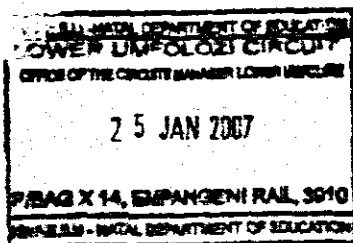
Kindly be informed that permission is hereby granted to you to conduct your research.
Please note the following:

1. Schools will participate on a voluntary basis.
2. Teaching and learning activities will not be disturbed.
3. Access to schools will have to be negotiated with the Principals.
4. Report to the Circuit Manager – Lower Umfolozi Circuit on completion of your Project.

I wish you all the success in your undertaking.

Thank you.


S. Ngema
Circuit Manager





PROVINCE OF KWAZULU-NATAL
ISIFUNDAZWE SAKWAZULU-NATALI
PROVINSIE KWAZULU-NATAL

DEPARTMENT OF EDUCATION
UMNYANGO WEMFUNDO
DEPARTEMENT VAN ONDERWYS

Telephone : 035 901 1300
Fax : 035 792 6059

Private Bag X 20104
Empangeni
3880

Cnr. Maxwell Street & Hancock Avenue
EMPANGENI
3880

ISIFUNDA SASEMPANGENI EMPANGENI DISTRICT EMPANGENI STREEK

Enquiries: MRS GMP SIDAKI
Imibuzo:
Navrae:

Reference:
Inkomba:
Verwysing:

Date: 06.03.2007
Usuku:
Datum

Mr SP Mchunu
P.O Box 2047
EMPANGENI
3880

Dear Mchunu

RE: APPLICATION TO CONDUCT RESEARCH –

Your letter dated 22 January 2007 refers.

I have pleasure in informing you that your application to conduct research amongst the schools in Empangeni District has been approved.

All the best with your research.

MRS GMP SIDAKI
DISTRICT DIRECTOR