Identifying the need for the development of an instrument to determine senior phase teachers’ science-assessment competence.

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Port Elizabeth
December 2002

DECLARATION
I, Elsa Helena Lombard, hereby declare that –

➢ This dissertation is my own original work.
➢ All sources used or referred to have been documented and recognised.
➢ This dissertation has not been previously submitted in full or partial fulfilment of the requirements for an equivalent or higher qualification at any other recognised education institution.

Elsa Lombard
ABSTRACT

The focus of this study is the competences expected of teachers in the senior phase to assess the Natural Sciences learning area. In order to be in line with the new developments, the South African science teacher will need relevant assessment training in order to utilise appropriate techniques that are in line with the new educational philosophy. The question arises: What competences do teachers need for assessing science in the senior phase?

An ethnographic case study was implemented as research methodology in the descriptive research paradigm. The investigation comprised observing the classroom practices of a sample of three senior phase science teachers in two primary schools and in one secondary school in the Port Elizabeth region. The data obtained from the observations were triangulated with related artefacts produced by both the teachers and the learners in each case. In order to establish these expected competences a document analysis was done from a selection of South African documents. The descriptions of the real life assessment practices of the sample of science teachers were then compared with the competences expected by the South African education system.

The comparison between the real-life assessment practices and the expected practices concurred with Shepard’s (2000, p.12) belief that the abilities needed to implement classroom assessment “are daunting”. The classroom-based assessment practices of the sample of teachers revealed a variety of assessment beliefs, practices and competence. The needs of these teachers are so diversified and intense that individualised professional development is needed if sustained implementation of the new curriculum and accompanying assessment competences is to be facilitated.

The research established the need to develop an instrument that the science teachers can use to assess their own competence. There should be training modules drawn up in line with this instrument. Teachers should be able to choose the professional development modules that would address their own unique needs.
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“Wysheid begin met die dien van die Here;
wie die Heilige ken, het werklik insig.”

Spreeke 9: 10

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Port Elizabeth
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List of Abbreviations

DoE: Department of Education
ECDoE: Eastern Cape Department of Education
GET: General Education and Training
NQF: National Qualifications Framework
SAQA: South African Qualifications Authority
C2005: Curriculum 2005
OBE: Outcomes Based Education
RNCS: Revised National Curriculum Statements
GETC: General Educational and training Certificate
COTEP: Committee on Teacher Education Policy
E: Elsa
M: Michael
A: Annette
G: Grace
L: Learner
Ls: Learners

Chapter One
Overview

1.1 INTRODUCTION

Education has gradually become a premier public policy issue. The highly competitive and changing world that confronts young people has increased the demand for schools to develop competent citizens, capable of flexible thinking and of independent learning. If schools are to meet these demands, then they must have an ongoing commitment to an appropriate and a relevant curriculum, with quality teaching and learning informed by good practice in assessment.

This study looks at the assessment practices of senior phase science teachers in South Africa in order to:

- gain a better understanding of the assessment practices of a group of science teachers;
- determine the assessment competences expected of a science teacher in this phase of the General Education and Training band; and
- establish the need for the development of an instrument to determine teachers’ science-assessment competence.

This chapter gives a broad overview of the context of the study and establishes its significance. The delimitation of the study hones in on the slice of educational reform being addressed, while the research methodology contextualises the research question and data collection techniques. A hint at the literature review is provided, together with an explanation of the terminology used within the study. The chapter concludes with an outline of further chapters.

1.2 CONTEXT OF THE STUDY

Curriculum 2005 (DoE, 1995a) introduced by the Department of Education (DoE) presents a change in the approach to teaching science, but are complementary changes in classroom based assessment practices taking place? In order to answer this question in a South African context the historical background of South Africa’s Education system, as well as its assessment system, needs to be determined.
The reforms in teaching techniques and assessment may be compared to the classic tale of the hare and the tortoise: where improvements in teaching are sprinting ahead while assessment reforms are lagging behind. Now we are ready to reduce the disparity between what we attempt to teach and what we try to assess. Although the bond between teaching, learning and assessment is inseparable, assessment should be regarded as the servant and not the master of the curriculum. It is essential to remember that it is assessment that helps us distinguish between teaching and learning. The focus of all classroom-based actions should be on learning. Most educational assessments - formal and informal, summative and formative - occur in the classroom and are administered by classroom teachers. Yet, Jones (1997, p.1) claims that the average teacher-training curriculum provides teachers with little or no training in assessment. Hence, too often, “teachers lack important knowledge and skills necessary to accurately and successfully use assessment to measure student development and ability” (Jones, 1997, p.1). Currently, this is the situation that prevails in South Africa.

It is becoming more apparent that assessment is a uniquely human activity (Broadfoot, 1994, p.139) but that teachers lack assessment knowledge and skills. Addressing this need would be a particularly challenging task, given the realities of the educational context in South Africa. One of the most serious legacies of the previous education system has been the collapse of the culture of teaching and learning in many educational institutions. This eroded the professionalism of educators (DoE, 1997b, p.2). The introduction of new policies for assessment will facilitate an increase in the quality of teaching and learning for all South Africans, but to be effective they must take cognisance of the present contextual landscape of the South African education system. This study intends to address just that issue.

The role of assessment in the context of a school curriculum has undergone considerable change during the past decade. Schools are expected to assess and to report on what students actually understand, know and can do. In South Africa, this new approach of assessment for monitoring and supporting teaching and learning has not been common practice. The assessment landscape in South Africa previously focused on competition and examinations with grades, while the new assessment landscape in the General Education
and Training (GET) band focuses on reflection and on the community. In the past, assessment was not considered to be part of the process of quality education, except as a final product. Currently, examinations still dominate the education process (Lolwana, 1996, pp. 183 - 189) since the corresponding changes are not implemented in the Further Education and Training (FET) band. The final Matriculation Examination in South Africa still acts as an instrument of selection for access to any further education and for entrance to the job market. As such it still enjoys a high status. The entire school education system still works towards preparing the learners to pass the matriculation examination. The requirements and perceived best practices needed to pass the matriculation examination spiral down to the lower standards and dictate the assessment practices in the lower grades. Teachers of the lower grades see the culmination of their efforts as the success rate of their learners in the matriculation examination. They only have the matriculation examination as an exemplar of good assessment practice.

For assessment within a matriculation certificate, little emphasis was placed on the teacher’s ability to assess in a variety of situations. Teachers, therefore are inadequately prepared for the expectations and the demands of the newly implemented Curriculum 2005 (c2005). Although changes in the assessment system from Grade 4 started as early as 1995 with the introduction of a continuous assessment system for all South African schools, (DoE, 1995a), the implementation and corresponding professional development of teachers did not prove to be successful. The lack of teacher preparation for implementing a continuous assessment system in South Africa is highlighted in the National Policy on Teacher Supply, Utilisation and Development (DoE, 1997b, p.31).

Implementation of the new curriculum (C2005) for the GET band of the National Qualifications Framework (NQF) introduced the GET Certificate as the first exit point in the educational system for South African learners. Central to the new policies is the assessment of learners' performance that will be judged against outcomes. Outcomes will function as organising concepts, and learners’ progress will be assessed against those outcomes (DoE, 1998a, p.9). Therefore, assessment is an essential element of an Outcomes-Based Education (OBE) system. Since the implementation of an Outcomes-Based approach to education and training, the subsequent new C2005 and the accompanying
implementation of a criterion-referenced assessment system are high stakes innovations. Lolwana (1996, p.189) predicted that in South Africa, "the implementation period [of the educational reform] will be more challenging than the policy-making phase". To add to the complexity of the implementation process, there is an absence of a tradition of trust in teacher judgements and school based examining in South Africa (Lolwana, 1996, p. 183).

The introduction of C2005 resulted in policymakers developing policies outside the reality of the classrooms. Although the teachers were consulted as stakeholders, the development was considered to be top-down. This resulted in problems with the implementation of the new curriculum. A review committee concerned with the implementation of C2005 under the chairmanship of Chisholm (DoE, 2000a) identified the problems encountered with the classroom practices. The presence of the problems created a need for an in-service training programme for teachers growing out of classroom practice. The focus here would be on the skills needed by teachers in order to successfully use assessment and to align the curriculum and assessment practices. Although South Africa does not want to remain in a situation where it is not in line with the global changes, the In-service Education and Training (INSET) should also not lose focus of the practicing South African teacher.

The White Paper on Education (DoE, 1995b, p.29) recognises that teacher development plays a significant role in the transformation process. The previous minister of Education regarded “teacher education as one of the central pillars of national human resource strategy, and the growth of professional expertise and self-confidence as the key to teacher development” (DoE, 1995b, p.29). As already pointed out, the Chisholm report on the implementation of C2005 (DoE, 2000a), found INSET to be crucial for the future success of Curriculum 2005. Since the assessments for the GET certificate will take place internally, it is imperative to train and to expose teachers to reliable and valid internal assessment practices. Consequently, INSET training should be embedded in classroom practice to provide teachers with the necessary competence to fulfil their role confidently. It is within this context that there appears to be a need for trainers to have a clear understanding of the assessment practices of teachers in general and science teachers in particular.
1.3 **SIGNIFICANCE OF THE STUDY**

Policymakers and the community in general will benefit from this study and the increased likelihood of success and sustainability of C2005. There is likely to be an increase in the accountability of the teachers, as well as a building of a new relationship of trust in the results of classroom-based assessments. It will allow South African teachers to align their practices with the latest developments in the area of valid assessment procedures with the aim of improving the quality of the delivery of education.

Also, this study may serve as a starting point from where teacher educators and those who are responsible for in-service teacher development can address the common deficiency of assessment knowledge held by the teachers. The next generation of teachers need to be comfortable with assessment demands, since teachers are the key to successful implementation of any assessment system (Madaus, Raczek & Clarke, 1997, p. 20).

The research community considers professional development of teachers as a critical factor in the improvement of education (Falk, 2000, p.130; Fensham & Northfield, 1993, p.67). Numerous studies done in America report that increased professional knowledge on the part of the teachers yields higher levels of learner achievement (Falk, 2000, p.130). Teachers will benefit from the development of an assessment instrument since it will allow them to undergo individualised professional development.

The need for professional development arises from the following two aspects. Firstly, the South African government has placed most of the responsibility for the successful implementation of C2005 on the shoulders of the teachers (DoE, 1997a, p.13). These new policies also place emphasis on both development and accountability in the assessment practices. Decisions regarding teaching and learning are placed, generally, in the hands of the teachers themselves. Since teachers will be in a position to receive professional development that will address their own weaknesses and strengths increasingly, they will be more accountable for the quality of evidence of their assessment.

Secondly, the teachers are known to be insecure and ill-prepared for the implementation of a criterion-referenced continuous assessment system (DoE, 1997a, p.31). This study
provides the backdrop for the sustained implementation of such an assessment system, since the first time that C2005’s outcomes are made explicit and specific is when assessment tasks are written to assess the achievement of the outcome in a classroom. An assessment task is the operationalisation of an outcome into a specific task by an individual teacher. The teachers, by default, then become the people who determine what an outcome means.

The C2005 implementation review committee reported that teachers possess a shallow understanding of the new curriculum, are unable to integrate the curriculum and assessment and are inadequately prepared for the assessment of the specific outcomes in the curriculum (DoE, 2000a). This may leave some teachers vulnerable since it is a huge requirement or expectation for teachers that were never expected to do something like this in the past. Without adequate professional development, a science teacher will enter a potential minefield when choosing, designing or adapting assessment tasks for use in classrooms. Without valid assessment procedures, they might not know whether or not the outcomes on which the programmes were focussed, have been achieved.

This study will assist teachers to gain dedicated and relevant insight into professional development in science assessment. Goodwin (1997, p. xiii), basing reform on implementations done in America, advises policy makers against the danger of implementing policies without the necessary sustained professional development of the science teachers who need to implement the policies. Indirectly, the improvement of teacher competence in the assessment of science will improve learner achievement since assessment, teaching and learning are intricately bound.

Lastly, knowledge of what happens in the classrooms can provide vital information to challenge our assumptions (Myers, 1999, p.6) about what is practical and realistic in terms of assessment in the senior phase of the GET band.

1.4 DELIMITATION OF THE STUDY

The principle on which this study was planned involves an investigation into the classroom-based assessment practices of a cohort of science teachers. This allows for a theorising of the practices of teachers in order to develop an instrument grounded in the South African
context. This aspect will be discussed in more detail further in the study. As a result of the researcher’s own background as a teacher educator, personal beliefs are prevalent. This can be seen as an asset and not as a threat to the study.

Specifying the science curriculum intentions for South Africa will require collecting information from every document in every province in South Africa. Such data collection will be neither practical nor economically feasible. Being located in the Eastern Cape, the main target population for this research would be in the Eastern Cape geographical region with Port Elizabeth as the focus. The schools chosen, consequently, are from the Port Elizabeth urban area and no rural school either with limited or no resources has been included in the study. All the schools chosen are close to community resources and have access to some material resources. The reason for that was to find out how resourced schools implement assessment practices.

The case study was limited to the Senior Phase of the GET band of the NQF because a new curriculum was introduced in this phase and it is the first exit point of the band. This study was carried out during the fourth term of the first year for the first school, during the second term of the next year for the second school and during the fourth term of the second year for the third school. The length of time spent with each teacher allowed me to observe a complete learning cycle in order to get a perspective, ethnographically, of the classroom practices of the teachers.

This study focuses on professional classroom assessment competences, not on reporting and grading, which is considered to be the administrative actions of classroom assessment. The policy documents from the national DoE and the training documents of the Eastern Cape DoE focus very heavily on the recording and reporting aspects of classroom assessment, neglecting the classroom based competences. This study therefore limits the focus to the professional assessment of learning in the science classroom. The related grading and reporting competences could be addressed in further research emanating from this study.

1.5 **Research Methodology**
The purpose of this study is to identify appropriate competences that might provide a framework for the scope and level of assessment competences needed by science teachers in the Senior Phase of the GET Band. Teachers’ science-assessment competency is a contemporary phenomenon in a real-life context, with no clear boundaries between the phenomenon and the context. As descriptive research (Schumacher & MacMillan, 1993, p.231) is concerned with the present, the current status of what exists, this approach is well suited to this study. An in-depth case study, using three teachers has been completed. Ethnographic elements in the research design allow the researcher to explore the science-assessment competence that teachers display over a period of time.

Impara (1995, p.1) identifies several methods one might use to determine the level of skills and knowledge of educational practitioners in the area of student assessment. A method particularly suitable for teachers is to examine the assessment tasks they develop and then to infer their knowledge of assessment principles from the tasks. This method provides only limited information about their knowledge of assessment skills. The skills to be measured can also be identified by undertaking a job analysis, for example, to establish what assessment skills and knowledge science teachers need to perform their job. Since limitations exist in each of the individual elements, this research uses an integration of document analysis, focusing on descriptions of the teachers’ assessment role, their assessment tasks as well as an ethnographic observation of the teachers’ classroom practice.

This investigation of the assessment practices in science classrooms will not be done from a “deficit model” (William, 2001, p.172), by establishing how far the assessment practices of the teachers fall short of the competences expected of them by international and by national experts. Instead, the need for training will be established from what is actually being done and to get a balance between theory as the ideal and practice as the reality.

1.5.1 Research question

Do the assessment practices of senior phase science teachers warrant a need for the development of an instrument to determine the minimum science - assessment competences required of these teachers?
1.5.2 Sub-questions

As they represent the major research areas for the study, the sub-questions listed below shaped the research.

1. How do three senior phase teachers assess science in the General Education and Training Band?
2. What assessment competences are needed for effective science assessment in South Africa?
3. What is the result of combining what exists with what is needed in South Africa?

Various data collection strategies were employed to answer the above sub-questions.

1.5.3 Data collection

Data collection strategies for sub-question one include in-depth non-participative classroom observation of the three teachers, unstructured interviewing of the teachers participating in the study as well as the analysis of any artefacts produced by the teachers and the learners in their classes. The multiple means of data gathering will be used to accommodate the complexity of the study (Glesne & Peshkin, 1992, p.7). This will also contribute to the trustworthiness of the data (triangulation) and increase the rigour of the study (Glesne & Peshkin, 1992, p.24). The focus of sub-question one will be on a description of the teachers’ assessment practices with their particular educational environments as background for the descriptions.

An analysis of the South African documentation regarding the assessment practices expected of science teachers by the NQF, the national DoE and the Eastern Cape DoE, will be done in order to answer sub-question two.

The answer to sub-question three will be provided by comparing the expectations of the South African policy makers and the assessment practices of science teachers in order to establish whether or not there is a need for the development of an instrument to determine senior phase teachers’ science-assessment competence.

1.6 LITERATURE REVIEW

The dominant discourse in the educational literature has changed dramatically over the last few decades. Internationally, assessment has generated much interest and concern. The
question that arises is “Why is assessment such an important issue?” Assessment is a complex area, with the interaction of new aims, new learning approaches and with multiple and often conflicting purposes (Black & Atkin, 1996, p.93). It has an impact on everything and everyone in the educational system.

Internationally, current assessment functions, procedures and techniques are changing in order to correspond with a new approach to teaching and learning.

Assessment has become “the pre- eminent means for social mobility, an engine for economic growth, and the mechanism for inculcating a sense of national unity” (Moses in Capper, 1996, p. v). Assessment is not only the engine but also the odometer of reform. The Commonwealth and State Training Advisory Committee (COSTAC) (1990) identified the area of assessment as one of considerable weakness and noted that further research endeavours in this area would be timely.

The literature study is organised in two parts. Firstly, it involves a discussion of the features of the new approach to assessment in general after which South Africa is situated in the context of the global education system. Next, a framework for the assessment of science is offered with a move towards the development of an assessment strategy for the assessment of science in the senior phase of the GET band of the South African NQF.

1.7 DEFINITIONS
This section clarifies relevant terminology used in this study and explains several concepts that are critical to understanding the assessment competence of teachers.

1.7.1 Test
Capper (1996, p.27) defines a test as "a specific instrument or systemic approach of observing and describing one or more characteristics using either a numerical scale or a classification scheme". In my study, it involves paper and pencil instruments as well as observations, and is used in the classroom to make decisions about individual students.
1.7.2 Examination
Examine implies an attempt to investigate, to inquire, to probe, to understand and to learn what the student has attained. The purpose of an examination is essentially to differentiate among learners (Somerset, 1996, p.267). In this research, the term examination will be used to refer to written assessments used at the end of the learning cycle (year or semester) to make decisions regarding certification, selection, or promotion (Capper, 1996, p.27).

1.7.3 Measurement
Measurement is defined as the process of reporting a student’s performance on a numerical scale (Nitko, 1997, p.29). A scale reflects quality of learning through a quantitative score or mark. Higher marks mean a higher degree of learning or competence. Measurement is descriptive in that it merely describes, very often in the form of a score, grade, or other numerical reading, how well the students have performed or how much students have learned.

1.7.4 Evaluation
Evaluation is defined as the process of judging the goodness or worth of a student’s performance (Nitko, 1997, p.29). Evaluation involves an interpretation of what has been gathered through measurement, in which value judgements are made about performance (McMillan, 2001, p.10).

1.7.5 Assessment
Educational assessment is a separate concept from psychometrics since the data for educational assessment arises as a direct result of instruction and is therefore crucially affected by teaching and teachers (Wood in Gipps, 1996, p.255). Ebenhezer and Haggerty (1999, p.351) define assessment as the process of gathering information obtained through multiple ways in multiple contexts for the purpose of making decisions about what and how much (qualitative and quantitative) students are learning. The term assessment, then, only refers to the process of gathering relevant information, not to the instrument for gathering it.
1.7.6Criterion-referenced assessment
The definition of criterion-referenced assessment used in this study is taken from the South African DoE (1997a, p.46). Criterion-referenced assessments mean that learner’s progress will be measured against criteria that indicate attainment of learning outcomes, rather than against other learners’ performance. All who meet the criteria for achieving specified learning outcomes would receive a credit.

Criterion-referenced assessment looks at the individual as being individual rather than in relation to other individuals and uses assessment constructively to identify strengths and weaknesses individuals might have so as to aid their educational progress (Gipps, 1996, pp. 254, 255). Criterion-referencing looks at the performance of the individual learners and at what they can do in defined domains, such as biology, practical work and so on (Swain, 2000, p.141).

1.7.7Competence
Competence is characterised by an ability to perform a task satisfactorily on the condition that the task was clearly defined and the criteria of success being set out alongside this (Whitty & Wilmott in Cain & Kickham, 1995, pp. 152, 153).

Competence must be inferred from observations of performance or behaviours and, often, this is not straightforward. Competences can therefore be considered to be standards of vocational performance (Fletcher, 1997, p.12). Bellis (2000, p.3) defines competence as “when skill(s) are performed in a context, to standards and integrating knowledge and its application. For competence to be useful to education and training practitioners, statements pertaining to what is to be achieved and how to recognise professional attainments have to be made clear.

In this study, competences are treated as tentative predictors of professional effectiveness and the science assessment competences identified are based on an analysis of the professional role(s) and a theoretical formulation of professional responsibilities of science teachers in the senior phase of the GET band.
1.8 **Outline of the Chapters**

This study looks at the assessment practices of senior phase science teachers in order to gain a better understanding of the assessment competences needed for effective science assessment in South Africa; the ways in which a sample of three senior phase teachers assess science in the GET band; and the result of combining what exists with what is needed in South Africa. In attempting to achieve the above-mentioned goals, an analysis of international and South African literature on the effective assessment of science has been done.

Chapter 2 provides a framework to address the sub-questions. Literature is provided with regard to the transformational process of education in South Africa. This is placed within a perspective of what is being advocated internationally. The chapter then focuses on the internationally accepted approach to quality assessment of science.

Chapter 3 provides a rationale for the research methodology applied in the study. The research tools used are discussed. Chapter 4 involves the description of the data from the classroom observation, the interviews and the artefacts of the teachers and the learners. This description of the assessment practices of the sample of teachers will answer sub-question one.

Chapter 5 will deal with the document analysis of relevant documents regarding legislation and policies that will influence the assessment practices of science teachers, to complete answering sub-question two.

This analysis is continued in Chapter 6 where the expectations illuminated in Chapter 5 will be compared with the reality of science classrooms, to answer sub-question three.
Chapter Two
Literature Review

“Assessment is a snapshot of moving things, but the movement, that is learning, can be enhanced by a teacher’s input. Assessment can help maximise the effectiveness of that input” (Qualter, Strang, Swatton & Taylor, 1990, p.125).

2.1 Introduction

It is not the researcher’s intention to contest whether or not teachers’ assessment practices influence learning. Hence, the aim of this study is to identify the assessment competences expected of a science teacher in the current South African context to maximise the positive influence of teachers on learning. To conclude whether or not a teacher is competent in an area of teaching implies that the attributes of competence are known. Unfortunately, it is only the areas (and not the attributes) in which a teacher should be competent that are well documented internationally and in South Africa.

One of the reasons why it is important to know the criteria and to describe them explicitly is to develop a framework for the professional development of teachers. One type of audience the study has in mind is teacher-educators. Providing valid training and assessment and certifying that teachers are competent in the assessment of science in the senior phase of the GET band in South Africa are what interest teacher-educators the most. Assessing is much more difficult when there is no clarity in the identification of the criteria constituting competence (Stones, 1994, p.237).

The National Department of Education (DoE) determined Norms and Standards for Educators as national policy in 2000 (DoE, 2000b). As part of the Norms and Standards expected of Educators, seven roles of an educator were identified. The area of Classroom Assessment was identified as one of the areas in which a teacher should be competent, but consensus on the critical attributes of being competent in the area of classroom assessment, does not exist yet in the South African context.
This chapter aims to bring together the new approaches in assessment practices in general followed by the assessment of science. As a backdrop to science assessment in South Africa the theoretical underpinning of change in assessment practices in the South African education system is presented. The South African education system is considered in the context of what exists globally.

2.2 **The transformation of the South African education system**

The history of South Africa’s education system is described by the White Paper on Education and Training (DoE, 1995a, p.18) as “… by a large measure the most developed and resourced system of education and training on the African continent”. At the same time, there are conditions that resemble those in the most impoverished states of Africa. “A majority of students drop out prematurely or fail the senior certificate examination, and access to professional and technical careers requiring a strong basis in mathematics and science, is denied to all but a fraction of the age cohort. This is largely because of the chronic inadequacy of teaching in these subjects” (DoE, 1995a, p.18).

The National Department of Education, therefore, had to commit South Africa to a National Reconstruction and Development Programme within a context of global change in which quality improvement features prominently. South Africa needed to align the South African Education and Training system to emerging international trends of best practice (SAQA, 1999b, p.3). The present Government (African National Council) developed a Policy Framework for Education and Training that identifies the development of science as a key element, thus aiming to improve quality in science education.

The challenge that South Africa faced in the development of the new Policy Framework was to develop and to implement system-wide sustainable intervention to address the problems in education in general and in science education in particular (Volmink, 1996, p.102). Then South Africa adopted an Outcomes Based approach to the education system as a vehicle for achieving the type of transformation seen as necessary and as desirable in a fledgling democratic
country. In 1998, the NQF was established while the South African Qualifications Authority (SAQA) was to oversee the implementation of the NQF and its underlying principles. At the same time new norms and standards for teacher education were being developed (DoE, 2000b). The NQF is essentially an assessment driven framework (SAQA, 1998). For this reason “improving expertise among educators in designing, developing and using appropriate assessment instruments, must be given priority” (SAQA, 1998, p.10).

The task of educational transformation is particularly challenging given the realities of the South African educational context. One of the legacies of the previous education system has been the collapse of the culture of teaching and learning in many educational institutions. Consequently, the professionalism of educators has been eroded (DoE, 1997a, p.2). The Government’s goal of quality teaching and learning for all South Africans will not be achieved unless the culture of teaching and learning is restored. New policies based on the innovations will be a critical means to this end, but to be effective they must take cognisance of the present contextual realities, while developing teachers for the future. A host of other features of science education complicates the context. Some of these features include a gross shortage of science teachers, the underqualification of science teachers, the inappropriate initial education of these teachers (Volmink, 1996, p.106), and so on.

A key principle underpinning the reconstruction of teacher development is the improvement of quality. In South Africa, a push for accountability is coming from centralised government sources. The DoE (1997b, p.71) considers quality as the means for ensuring accountability. Education needs accountability, but accountability must contribute to the growth of students (Lazear, 1999, p.86). Assessment of student performance is emerging as a crucial ingredient in the recipe for ongoing improvement of school science. Increasingly, assessment is being used not only to monitor student achievement by acting as the gateway mechanism, but also to evaluate the competence of the educators and the quality of the educational system (Mabry, 1999, p.2; Moses in Capper, 1996, p.v). Knight supports this argument with the statement that “assessment and quality go

According to Knight (1995, p.13) a mission statement, a programme plan or a validation document allows the institution to lay claim to a wonderland of concepts, skills, competencies and the like, of which the students are to be made citizens. For those who really want to know about the quality of a course, programme or institution, the test is whether or not these goals are assessed and how well these goals are assessed. Assessment provides the operational definition of any form of standard and quality. It describes what should be taught and learned in classrooms. It has become increasingly apparent that what is tested gets taught and how something tested influences how it gets taught and learned. The notion of a “moral issue” is introduced by Knight (1995, p.13) since what we choose to assess (or not to assess) and how, shows what we value.

In this process of reform, new conceptions about instruction such as teaching for understanding, portrayal of student performance (Volmink, 1996, p.105) and new conceptions about assessment like assessment for learning (Wilmot, 1999, p.257) evolved. The new policy for Assessment in the General Education and Training band for South Africa (DoE, 1998a) articulates a vision for South Africa that brings South African education in line with international trends in assessment (Wilmot, 1999, p.257). The complexity of this education change was recognised by commentators such as Volmink, who, as early as 1996 (p.105), suggests an adoption of a systemic approach to change if any sustainable change was to take place. Volmink (1996, p.105) also argues that in order to bring about the necessary changes, the “critical nodes of the system where leverage for change is most possible”, should be identified.

The critical node I have chosen to address is the assessment practices of the science teachers in the Senior Phase of the GET Band. The senior phase of the GET Band is the first exit point of the 9-year compulsory general schooling band in South Africa. It is proposed that this will culminate in an externally examined qualification, the General Education and Training Certificate (GETC). The GETC...
will be an important qualification in the country. For many it will be an exit
certificate attesting to their achievement during compulsory education. For others it
will be a stepping-stone to further studies either in schools or through a work-based
route. Therefore, change in this phase has the power to influence the previous
years’ practices as well as the products of this phase, the bulk of which will leave
South Africa’s education system. The use of external assessment to set an exit
standard for compulsory education will substantially alter the shape of the provision
up to that point. This will influence the nature of the assessment arrangements that
are made and put even more pressure on the teachers to be competent in
assessment.

Another reason why the senior phase was identified as part of the critical node of
the education system, is that the expectations of the National DoE are available
through the policy documents for C2005 that serve as the curriculum for the GET
Band. This gives researchers more than just speculation on which to base their
recommendations for systemic change. Therefore, this study examines senior
phase science teachers as the population for the study with the focus on their
assessment practices.

Assessment has an impact on everything and everyone in the education system.
Assessment results are used throughout educational organisations as a basis upon
which to make important educational decisions. It serves as the primary feedback
mechanism in the science education system. It has become “the pre-eminent
means for social mobility, a drive for economic growth, and the mechanism for
inculcating a sense of national unity” (Moses in Capper, 1996, p.v). It is an
important tool for good inquiry into teaching. In South Africa specifically,
assessment increased in value, as education competed with other sectors for
scarce public resources. Lolwana (1996, p.188) points out that “more than ever it
is the assessment methods that will produce an effective system and that is the big
challenge”.

In the case of curriculum reform, new assessment practices are almost inevitable
since the existing practices are unlikely to be congruent with the intentions of the
reform. There is a need to align student assessment practices with curricular aims, instructional practices, and performance standards. According to Knight, “a good fit of assessment schemes with programme aims and teaching methods is considered an indicator of quality” (1999, p.101). This places great responsibility on the teachers since the assessment practices could have a negative impact on the development of innovation. The assessment programme that the UK government put in place alongside their National Curriculum supports this view. The intention of that programme is to provide a key mechanism by which implementation of the curriculum is ensured (Torrance, 1996, p.10).

This highlights the importance of the need for professional development in teachers. Fensham and Northfield, (1993, p.63) point out that the relative failure of the curriculum packages developed in the 1960s and 1970s in the USA is often ascribed to inadequate attention being paid to teacher-education in relation to the changes in the science curriculum. They feel strongly that “the professional development of science teachers is the critical factor in improved science education” (Fensham and Northfield, 1993, p.63). Obinna (1997, p.9) supports this view and comments, “no policy succeeds without the implementers [the teachers] keeping abreast with what it is that they ought to implement”. He adds that change does not happen by mere declaration. It depends on the implementers’ perception of the change situation. The Committee on Teacher Education Policy (COTEP, 1998b, p.7) identified one of the weaknesses in teacher education, being that “too little focus [was put] on the development of teachers’ understanding of the appropriate use of a variety of assessment modes”.

When studying the reform in science education, then the relationship between the teachers’ assessment practices, the teachers’ competence and the quality of the education provided are essential. Volmink argues, “One of the most important aspects of educational reform is the calibre of the teaching force. If the teachers are not able to address the needs of their students and the demands of their subjects, other reform strategies will fail” (1996, p.107). Shepard (1995, pp.38-43) draws the attention to the extent and the depth of staff development needed to successfully implement assessment-driven reform. His experience shows “that
well-intended efforts to help learners improve at assessment tasks can be
misdirected if teachers do not understand the philosophical and conceptual bases
of the intended curricular goals”. This view is supported by the Committee on
Teacher Education Policy (COTEP) when they point out that “South Africa’s most
pressing educational problem is improving the quality of educators rather than
simply improving the quantity” (COTEP, 1998, p.113).

The framework for inquiry into assessment should be “systems thinking” (Volmink,
1996, p.106). A systems approach to the change recognises that all aspects of the
entity referred to as a system are interrelated by interacting processes. This
approach to assessment practice will allow intervention at the level of the cause,
rather than dealing with the symptoms. If adopting an outcomes based philosophy
is seen as systemic reform, then there is likely to be a dimension that challenges
current practices of curriculum development and delivery.

South Africa’s new implemented education framework has a vision that
assessment should “aim for growth and providing support” to the learner (ECDoE,
2000b, p.6). It is expected that the teacher provides time and support to each
learner to realise his or her potential. The emphasis is on the potential of
assessment to "enhance" achievement rather than on the means for reporting it
(Little, 1994; Stones, 1994). By implication, it is believed that assessment should
be a tool for learning. These changes in the curriculum involve a broadening role
for the teacher. The role and status of more routine teacher assessment has
become enhanced (Wolf, 1995, p.viii). There are increasing expectations for
teachers to develop higher levels of knowledge and skill in assessment. Generally,
teachers are changing the way they think about good teaching and assessment
practices are influenced by these changes. Such changes urge teacher educators
to rethink the attributes of capable assessors and so provide competent and
confident teachers needed for innovations in education. What follows are general
features that need to be focused upon in order to consider assessment practices.
2.3 GENERAL FEATURES OF THE NEW APPROACH TO ASSESSMENT

Current debates in education are centred on what comprises effective learning and teaching and how best to measure learning outcomes. A shift in thinking about assessing student learning from a culture of testing to a culture of learning took place during the past decade. Teachers are changing the way they think about good teaching and the assessment practices are influenced by this change (National Academy of Sciences, National Science Resources Centre, Smithsonian Institution, 1997, pp.1,2).

Assessment, therefore, has many roles in education and stakeholders will focus on a role, a purpose and a function that suits their needs. There is a pressing need to teach such educators about the role, the nature and the limitations of assessment since real assessment lies in interpreting assessment information. In this respect, it is important for society to appreciate that simplistic interpretations and decisions based on inadequate information, are likely to do more harm than good. Consequently, teachers need to be competent in the interpretation of the different types of assessment information.

2.3.1 Assessment as a tool for learning

Learning is so driven by assessment, that the form and nature of assessment often swamp the effects of any other aspect of the curriculum (Boud, 1990, p.103). Assessment shapes the curriculum and embodies the purposes of education. As a result, assessment goals, assumptions and practices are inextricably bound to other parts of the educational framework of a country (Noah, 1996, p.88). The alignment of assessment with curriculum and teaching is one of the most critical aspects of science education reform (National Research Council, 1995, p.211). When learners engage in an assessment exercise, they should learn from it. Thus, there is an increased emphasis on providing an opportunity to learn (National Research Council, 1995, p.2) during assessment. Assessment needs to be “seamless” with both curriculum and teaching. This way, teaching and assessment becomes aligned and integrated (Nitko, 2001, p.148).
If assessment is used as a tool for learning, it can have a positive effect on student performance as suggested by Little's research data (cited in Broadfoot, 1994, p.140). Little suggests that assessment can make a real impact on learning quality since the kind of assessment regime used in the classroom, in fact the kind of learning environment created by different assessments, has an influence on the learners' motivation. Assessment must be good representations of the kinds of learning desired (Darling-Hammond & Falk, 1997, p.54). Unfortunately, there is also evidence indicating that the everyday practice of assessment is plagued with problems and shortcomings (Black & Harrison, 2000, p.32). “Assessment remains the weakest aspect of teaching in most subjects” (Ofsted cited in Black & Harrison, 2000, p.33).

The purposes of classroom assessment are interrelated and intended to serve different audiences, amongst others, (parents, learners, teachers and administrators). For example, assessment to support learning, offering detailed feedback to the teacher and the learner is necessarily different from assessment for monitoring or for accountability purposes. In order to support learning the assessments should provide information on what, how much, and how well learners are learning, in order to help them be better prepared to succeed. In broad terms, it involves reviewing and receiving feedback by both learners and teachers and, therefore, is formative or developmental by nature. Seeing that the teacher is interested in understanding where the learner is going wrong, the teacher needs to assess the process as well as the product. The process that leads to a product should be continuously assessed (Obinna, 1997, p.22). Continuous assessment concerns itself, therefore, with mastery of the learning process. This will be discussed later.

Assessment has a variety of roles ranging from selection and certification roles (Little & Wolf, 1996, pp.x–xii) to being an instrument of system reform (Gipps, 1996, p.253). The focus of this study is not on assessment’s gate-keeping role but on educational assessment geared towards facilitating science learning as discussed above. The two main purposes of classroom-based assessment,
formative assessment for learning and summative assessment of learning (Harlen, 2000, p.139) will be discussed in more detail.

In order to aid the teaching/learning process the purpose of the assessment should serve both the teachers and the learners through what can be labelled as the formative or pupil-centred purpose, such as diagnostic assessment, guidance and assessment for learning, and a summative or teacher-centred purpose, such as evaluation of curriculum, placement and selection.

Gipps (1996, p.253) takes the view that “the prime purpose of assessment is professional: that is assessment to aid the teaching/learning process”. Broadfoot (1994, p.139) builds on this notion by pointing out that the human aspect of assessment is the "means by which assessment can become a truly educational device", but also highlights the importance of teachers’ professional knowledge towards the success of providing valid assessments as part of the human dimension of assessment. The notion that assessment influences learning also has an impact on the role expected of learners in assessment. Learners have to take responsibility for their own learning through self-assessment. Thus, formative assessment plays a vital role.

2.3.2 Formative assessment
Formative assessment, usually associated with a constructivist perspective on the process of learning, appears to Torrance (1995, p.3) as a more dynamic approach to the relationship between assessment, teaching and learning. Torrance and Pryor (1998, p.153) suggest that teachers should think of formative assessment as part of their pedagogy and plan well structured activities that can have a positive formative impact. Bell and Cowie (1999, p.198) support that suggestion and define formative assessment as "the process used by teachers and students to recognise and respond to student learning”. They indicate that the purpose of formative assessment is to enhance learning while such learning is happening. Here, focus is on the learning activities provided by the teachers (the pedagogy) as well as the frequency of the assessment.
George and Cowan (1999, p.1) describe assessment as formative when the intention is to identify scope and potential for development. Their focus is on progress in learning, which has imbedded in it the notion of frequently assessing progress. Airasian (2001, p.6) focuses on the aspect of feedback when he argues that formative assessment is “the term used to describe feedback intended to alter and improve students’ learning while instruction is taking place”.

Since formative assessment implies analysis and diagnosis with the emphasis on growth and development, Stones (1994, p.240) prefers the term diagnostic assessment. Although formative assessment always will have an aspect of diagnosis in it, viewing it solely as a diagnostic aspect limits the notion of formative assessment. Broadfoot (1995, p.33) divides all assessment that focuses on students’ learning either into diagnostic assessment with the purpose of identifying individual learners’ strengths and weaknesses or else formative assessment with the purpose of giving feedback and encouragement. Diagnostic assessment can thus be seen as a monologue of the learner with the teacher – revealing his/her weaknesses or strengths. So, on the one hand with diagnostic assessment the teacher is not compelled to enter into a dialogue with the learner, while formative assessment on the other hand has the embedded principle of feedback and “feed-forward” in it. In order to achieve this the teacher has to enter into a dialogue with the learners about their strengths and weaknesses.

In this study, formative assessment is considered to be assessment that takes place on a continuous basis with the purpose of providing corrective actions to enhance student learning and as such includes diagnostic assessment. An assignment is formatively assessed when the comments that the teacher makes to the learner are intended to bring about improvement in the subsequent work thereby facilitating progression in the learning.

Bell and Cowie (in Black & Harrison, 2000, p.35) find it useful to distinguish between “planned formative assessment” and “interactive formative assessment”. Cunningham (1998, p.7) takes this notion further by differentiating between the types of decisions taken during formative assessment. Cunningham distinguishes
between planning decisions (decisions made prior to instruction that can be linked with planned formative assessment as described above) and process decisions (changes made during instruction indicating an interaction or interactive formative assessment as discussed in later paragraphs). During planned formative assessment, the teacher is concerned with the structured short-term collection and use of evidence for the guidance of learning, mainly in day-to-day classroom practice. It is used to determine the degree of mastery of a given learning task and to pinpoint the part of the task not mastered (Obinna, 1997, p.15), the notion of diagnostic assessment.

Planned formative assessment is more formal and structured than interactive formative assessment (Black & Harrison, 2000; Cunningham, 1998). Planned formative assessment, therefore, serves the teacher-audience, as described in the previous paragraph. Learners enter into a monologue with the teacher so planned formative assessment becomes part of the pedagogy of the teacher and should be planned carefully (as mentioned earlier by Torrance & Pryor, 1998, p.153). The purpose of planned formative assessment is to help both the learner and the teacher to focus upon the particular learning necessary for progression and takes place on a continuous basis during the course of learning.

Interactive formative assessment on the other hand is part of the classroom dialogue. Dialogue (involving both reviewing and giving feedback) is an essential component of formative assessment interaction where the intention is to support learning (Clarke & Sadler in Bell & Cowie, 1999, p.198). The emphasis shifts partly from the curriculum to the learner (Torrance & Pryor, 1998, p.156). This dialogue (feedback and “feed-forward”) allows learners to generate opportunities for furthering their understanding. The feed-forward is concerned more with the effect on current and subsequent learning than the effect on subsequent teaching. Learners receive feedback on what they know, understand and can do through teacher-learner interaction. The purpose of assessment is therefore to support learning (Bell & Cowie, 1999, p.198) and the process of learning (Harlen, 2000, p.137). How learners learn something or the process by which they learn will determine the quality of their product, their response, or their level of mastery of a
skill. The teachers notice, recognise and respond to student thinking during these interactions (Bell & Cowie, 1999, p.208).

As formative assessment is viewed as "occurring within the interaction between the teacher and learner(s), it is at the intersection of teaching and learning" (Bell & Cowie, 1999, p.198). This requires teachers to be supportive as well as to be critical of learners – a balance Torrance and Pryor (1998, p.159) warn is “extremely difficult to strike”. During the classroom observations, I will be looking at how teachers actually strike this balance in the science classroom. Interactive formative assessment thus depends on teachers’ skills of interaction with the learners and the nature of the relationships established (Bell & Cowie, 1999, pp. 208, 209).

Assessment is formative when information comes from a comparison of actual ideas, existing skills and referenced levels of achievement and used to alter the gap between the two levels, and not when comparisons are in terms of equality (that is, these are the same or are different) or as a distance (how far short of - or indeed beyond - the standards was it). Harlen (2000, p.138) argues that since formative assessment has to take account of all the aspects of learners that affect their learning, indicating what next steps to take instead of what is missing, it is not a pure criterion-referenced assessment. It is more child-referenced. Teachers will have in mind the progression that they intend for a particular child and this will be the basis for further actions taken. Thus, teachers need to know about how learners’ skills and concepts are developing if they are to help them to construct an understanding (Harlen, 2000, p.137). This implies a strong subject pedagogical knowledge. This notion of identifying, understanding and closing the gap, requires clear criteria against which performance can be judged.

However, no matter how precisely the criteria are drawn, it is clear that some judgement must be used when deciding whether or not a particular item or task performance does yield evidence that the criterion has been satisfied (William, 2001, p.171). This highlights the human aspect of assessment and the subsequent practical assessment of knowledge of assessment needed by teachers as referred to earlier. Sadler (in Coats, 1998, p.21) points out that feedback needs to relate to
learning goals or learning objectives to enable seamless assessment as discussed earlier in this section.

Coats (1998, p.21) also argues that feedback alone may not lead to improvement. Learners need to be involved in their own learning (Black & Harrison, 2000, pp. 26, 30; Harlen, 2000, p.138). The action to close the gap needs to be taken by the learner. Feedback from the teacher is not formative unless the learner can understand and act on that information (William, 2001, p.176).

In order to allow learners to take responsibility for their own learning during formative assessment, they have to be given the knowledge and skills to discharge their responsibilities (Simpson in William, 2001, p.177). However, for the teacher’s part, as William points out (2001, p.177), it is not enough just to “understand the standard”. What learners come to know during self-assessment is an awareness of the gap between current and desired achievement, but they are unlikely to have clear ideas of how to close the gap. “The essential role of the teacher in formative assessment, therefore, is to analyse the gap between present and desired performance, and to be able to break this down into small comprehensible steps that can be communicated to the learner” (William, 2001, p.177). Consequently, formative assessment requires teachers to understand the standard and the gap and also have a solid pedagogical content knowledge.

In summary, formative assessment encompasses all those activities, undertaken by teachers, and/or by their learners, which provide information to be used as feedback to modify teaching and learning activities in which they are engaged (Black & Harrison, 2000, p.25). For such a venture to succeed, the approach has to be applied consistently (Coats, 1998, p.23) and continuously. Bell and Cowie (1999, p.213) report on research that reveals formative assessment to be a complex, skilled task that relies on the teachers’ pedagogical knowledge. Effective teachers use a variety of formal and informal means to determine how much and how well their learners are learning. Teachers need to modify and to adapt the "feedback devices" both to fit the specific demands of science and the specific characteristics of their learners.
2.3.3 Summative assessment

Assessment for monitoring or for accountability involves the use of assessment information to make final judgements about a learner’s learning and a teacher’s success. Its primary purpose is to provide a “summary of” a learner’s achievement or progress at a certain point in time in the form of a grade or a score (Harlen, 2000, p.133; Cunningham, 1998, p.45; Obinna, 1997, p.15). The assessment most suitable for the purpose of determining whether or not learners have acquired specific knowledge or skills, which is a more teacher-centred purpose, consequently focuses on the products of learning.

Swain urges classroom teachers to realise the intrinsic value of summative assessment data and recommends that the results of summative assessment be used as an "automatic post-summative reflection" (Swain, 2000, p.153). Summative assessment data should lead to questions, to analysis, and hopefully to answers, in order to provide an essential ingredient in the feedback loop of teaching, learning and assessment (Swain, 2000, p.154). Swain (2000, p.154) supports Boud (1995, p.36) and points out that if the focus of assessment is on the improvement of learning, formative assessment and summative assessment could not be addressed separately in classrooms with separate assessment tasks. The characteristics of formative and summative assessment differ in timing and use of the judgements more than in the methods used for collecting information, resultantly formative assessment and summative assessment should be considered together at all times. This re-enforces the notion that assessment, entailing diagnostic, formative and summative assessment, should take place on a continuous basis if it is to assist learning (Harlen, 2000, p.139; Swain, 2000, p.153; Boud, 1995, p.36).

The fact that good summative assessment also can be used formatively does not mean that the results of formative assessment should be constantly recorded in order to produce a summative record (Pahad, 1999, p.251). Summative assessment requires a more rigorous design than normally is necessary for formative assessment. Formative assessment should not be automatically fed into
a summative record since each will have a difference in purpose (Pahad, 1999, p.259).

Harlen (2000, p.139) lists the characteristics of summative assessment as taking place at certain intervals when achievement has to be reported; it enables results for different learners to be combined for various purposes because they are based on the same criteria; it requires methods which are as reliable as possible without endangering validity; it involves some quality assurance procedures; and it should be based on evidence relating to the full range of learning goals.

“Ultimately, it is not the form of the assessment which determines whether or not it is formative or summative, but the use to which it is put” (Pahad, 1999, pp.250, 251). The kinds of assessment, the frequency of assessment, the detail or the recording: all these should depend on the type of decisions to be made as a result of the assessment. This brings us to another feature of the new approach to assessment, that of continuous assessment.

2.3.4 The role of continuous assessment

According to Parkinson (1994, p.198), continuous assessment happens at classroom level and it serves the following functions:

- Assists and supports learners in learning (it should be formative);
- Assists in identifying strengths and weaknesses (it should be diagnostic);
- Assists teachers in evaluating their teaching and learning programme (it should be evaluative); and
- Provides information on progress and achievement of individual learners for themselves, for parents and for a range of other people (it should be summative).

Thus, continuous assessment incorporates both formative and summative as well as diagnostic assessment as underlying practices (Nitko, 1997). As Bellis (1998, p.6) argues: “Continuous assessment ought to provide fair opportunity for progress and achievement “. SAQA endorses this view with their statement that "continuous
assessment embraces both formative and summative assessment” (SAQA, 1999a). Siebörger (1998, p.25) defines continuous assessment as assessments which take place on and off throughout a course or period of learning.

The American North Central Regional Educational Laboratory (N.C.R.E.L.) (n.d.) provides another perspective to continuous assessment. They argue that teachers can overcome the dilemma of relying on the results of a single assessment focusing on a limited sample of learner performance obtained by a performance assessment task, by “continuously assessing a student’s work over a long period”. The implication of this statement is that continuous assessment is not a repetitive or an accumulative result of the same type of assessment like, for example, multiple choice questions – but the use of a variety of assessment types (each selected for the collection of a particular type of evidence) over a period of time. The N.C.R.E.L. (n.d.) uses continuous assessment to enhance validity with the use of evidence collected from a variety of sources on which to base decisions instead of a single assessment based on a limited sample of the learner’s work.

Pahad (1999, p.249) points out that the word continuous assessment is used loosely in South Africa. Lately, it has been used interchangeably used with concepts such as “formative assessment” and “the new assessment paradigm”. Thus, it is of importance that teachers have a uniform understanding of the concept and how it is used in South Africa.

The new South African education initiative relies heavily on continuous assessment. For the GET band, learners will be assessed on a continuous basis by employing different strategies and the Curriculum Policy for the Senior Phase states that only at the end of grade nine will there be a comprehensive external assessment for the GET certificate (DoE, 1997a, p.19). The DoE’s Assessment Policy for the GET band describes assessment as a process with both formative and summative phases (DoE, 1998a, p.3). Therefore, it is preferable to talk about assessment as a continuous process with a formative and a summative phase, rather than talking about continuous assessment as an assessment strategy or an
assessment method. This may lead to misconceptions about the assessment practice involved.

In this study, the concept of continuous assessment is used to refer to the frequency of assessment opportunities provided to the learners to allow them to demonstrate their learning and achievement. It refers to the collection of evidence that takes place on a regular, ongoing, continuous basis throughout the learning and the teaching process for formative or summative purposes through the implementation of a variety of assessment types.

Continuous assessment requires a completely new thinking by teachers on education. The teacher requires new skills. For continuous assessment to be effective, learning and teaching must also be continuous (Obinna, 1997, p.11). Therefore, this study will observe the classroom practices of a sample of science teachers to see how they link learning, teaching and assessment on an ongoing basis.

Another characteristic of continuous assessment is that it takes cognisance of individual differences in learners, for instance, learning rate and style. Behaviour differs from one learner to another although the expected skill, concept and attitude may be the same (Obinna, 1997, p.17). In the continuous assessment system of individual development, the indices of measurement are ultimately expectations and set criteria (Obinna, 1997, p.11). The work of the teacher is to lead the learner through some meaningful experiences that will encourage growth. The manner in which learners learn or the processes by which they learn (which is unique to each learner) will determine the quality of their products, their responses, or the level of mastery of a skill; efficient assessment of these processes places emphasis on the need for teachers being competent in assessment.

With the advent of continuous assessment, teachers tested work covered during a week or few weeks, not paying attention to the natural progression in the work, and called it continuous assessment. This was a shortcoming in the way continuous assessment was achieved in the past. Obinna (1997, p.18) reasons that
continuous assessment requires a new type of assessment unit and each unit should consist of a number of elements. These elements can range from specific terms, and facts, through to more complex and abstract ideas such as application of principles and analysis of theoretical statements. Such elements form a hierarchy of learning tasks. Both learner and teacher must trace the process to the end. An effective assessment task should consequently relate to the content and take progression of individual learners into account, consequently avoiding being merely engaging to learners. I plan to observe the practices of the sample of science teachers with reference to how they structure their assessment tasks in order to avoid mere engagement with the learners.

The international trend in assessment is an emphasis on formative, learning-integrated assessment labelled by Broadfoot (1995, p.16) as “continuous teacher assessment”. Classroom assessment that meets the general features discussed in the previous paragraphs has the tendency to use formats that observe the learners’ work directly. The focus is on establishing what the learner can do, in other words performance assessment, as a result of learning and not what the learner can recall from the experiences.

### 2.3.5 Assessing performance

The focus is now on what the learner can do, namely demonstration/presentation, as a result of the learning, instead of merely focusing on what the learner can recall, namely memory testing, from the experiences. Assessment in which learners create an answer or a product that demonstrates their acquisition of knowledge or skills is labelled performance assessment (Airasian in Moore, 2001, p.281). Growing emphasis is being placed on using performance assessment to determine learners’ understanding of concepts they are taught and measuring the learners’ ability to apply procedural knowledge (Airasian, 2001, p.232).

Two of the factors that account for the popularity of performance assessment are, firstly, the international emphasis placed on problem-solving, higher-order thinking skills and real-world reasoning skills. This created a reliance on performance and product assessment to demonstrate pupil learning (Airasian, 2001, p.232; Gipps,
Secondly, performance assessment can provide those learners who do poorly in traditional assessments an opportunity to show their achievement in alternative ways (Airasian, 2001, p.232). Performance assessment gathers data on learners. It focuses on growth over time rather than comparing learners with each other and it allows the assessment system to meet the needs of diverse learning styles, cultural backgrounds, and proficiency levels.

Moore (2001, p.282) focuses on assessing the learners’ ability to translate knowledge and understanding into an action or a product. This requires learners to apply their knowledge and understanding in relevant problem contexts, an aspect that relates to the doing of investigations as will be discussed in more detail in the section on science assessment. Such application does not necessarily have to be within a real-life context (authentic assessment) as long as it resembles real-life tasks as closely as possible.

The American National Science Education Standards (cited by Voss, 2000, p.4) defines authentic assessment in science as assessment exercises that require learners “to apply scientific information and reasoning to situations like those they will encounter in the world outside the classroom as well as situations that approximate the intended outcomes of science education”. Authentic assessment measures educational objectives as directly as possible. As a result, authenticity is embedded in the process, not the specific kind of assessment procedure (Trice, 2000, p.241). Although not all performance assessment is authentic, it is difficult to imagine an authentic assessment that would not also involve a performance.

The growing interest in authentic assessment can be linked to the move toward outcomes-based education (Clark & Clark, in Moore, 2001, p.281) where the emphasis is on the learning that learners can demonstrate. In performance assessment, the student completes or demonstrates the behaviour that the assessor desires to measure. In authentic assessment, the student not only completes or demonstrates the desired behaviour, but also does it in a real-life context (Meyer, 1992, pp.39,40). In such a situation teaching and assessing become one and the same, thus setting the stage for linking instruction and
assessment (Moore, 2001, p.281). An implication is that teachers should know the
difference between describing how a skill should be performed and actually
knowing how to perform it (Airasian, 2001, p.229). In this study the focus is on
science education where performance assessment is seen as an umbrella term for
alternative assessment and authentic assessment in particular, since performance
assessment is ideally suited for the assessment of science at schools.

Therefore, performance assessment refers to the kind of learner response that
needs to be examined. An assessment approach is performance based if the
learners are expected to provide evidence of their learning. Cunningham (1998,
p.121) labels an assessment to be performance-based if the learner has to
respond by doing something other than selecting the correct answer from among
several choices or provide a single answer. The “show-your-work” types of
assessments, thus are important forms of performance assessments (Airasian,
2001, p.230). Airasian points out that these evidences may range from
performances by the learners to products made by them, as long as the purpose of
these performance assessments is to assess the learners’ ability to translate their
knowledge and understanding into action. The purpose is thus to assess learners
on whether or not they understand and can use the knowledge, not just recognise,
repeat and fill in the answers. Thus, performance assessments are particularly
suited to formative and to diagnostic assessment because they can provide
information about how a learner performs in each of the criteria that make up the
more general performance or product (Airasian, 2001, p.235). This implies that
performance criteria should be stated in terms of product characteristics or
observable learner behaviour to make remediation easy.

Performance assessments have two parts: a clearly defined task and a list of
explicit criteria for assessing learner performance or product. The performance
assessment should have a clear purpose and explicit performance criteria for
successful implementation. The teacher’s skill in deciding on and formulating the
performance criteria is crucial for the success of the assessment. Although
performance criteria are at the heart of successful performance assessment, they
are the area in which most problems occur (Airasian, 2001, p.235). Airasian (2001,
reports studies that show many classroom teachers lack skill in assessing and are unprepared to assess their learners on performance assessments.

The teachers need to identify decisions to be made from the performance and select the “essential” performance criteria for the assessment exercise (Airasian, 2001, pp.234,236). The explicit criteria of performance assessment helps teachers focus on aligning instruction and assessment (Airasian, 2001, p.251). It is necessary for teachers to develop a sense of realism about what can be claimed and achieved (Wolf, 1995, p.63) for them to be competent in making learning achievement judgements based on performances or products and then to make professional interpretations and decisions based on these judgements (McMillan, 2000, p.3). Teachers operate in terms of a holistic set of concepts about what an assessment “ought” to show and how far they can take account of the context of the performance (Wolf, 1995, p.67). The more experienced teachers will have an internalised model of competence (Wolf, 1995, p.71) but will have to constantly make major decisions since the contexts in which learner competence is displayed and assessed have an inherent variability (Wolf, 1995, p.68). The explicit criteria of performance assessment helps teachers focus on aligning instruction and assessment (Airasian, 2001, p.251). It is expected that teachers in the classroom will prepare their learners for assessment by giving them good instructions regarding the criteria they are expected to demonstrate.

Torrance (1995, p.46) identified adequate articulation and conceptualisation by teachers and of how higher-order skills and understanding can be taught and assessed, as being one of the possible problem areas of implementing performance assessment.

Airasian (2001, p.239) highlights the importance of criteria that can be observed and be judged. A teacher’s professional skills in direct observation and evaluation are consequently emphasised in a way that was missing from test-driven curricula (Grady, 1992, p.13). Since the information provided by the performance assessment tasks is rich as it tells the teacher more about what learners can do, it complicates the process of making the comparisons necessary for assigning
grades (Cunningham, 1998, p.130). Scoring performance assessment is difficult (Airasian, 2001, p.251). Teachers' interpretations and judgements are necessary for scoring performances and products. It is subject to many distractions not relevant to scoring such as quality of handwriting, neatness, colouring in, knowing the learner that influence the teachers' judgement thus affecting the validity of the assessment. The validity of performance assessments is influenced mostly by two factors, namely, bias and mental record keeping, rather than written record keeping (Airasian, 2001, p.253). Meticulous and comprehensive record keeping of the assessment evidence is of the utmost importance. Judgements are biased when the judgements of the performance are influenced by the inclusion of irrelevant subjective criteria that act as distractors.

When performance criteria for scoring the evidence are vague and unclear or subjective, the reliability is reduced (Airasian, 2001, pp.254,255). Reliability is improved with a clearly stated purpose and the performance criteria stated in terms of observable criteria. As a result of clarity there is less interpretation needed by the teachers, which will consequently lead to less variability (Airasian, 2001, p.255). The criteria for assessing the task are included in the learners' instructions for the task so that the learners are aware of the basis for their evaluation. Teachers should give the learners these criteria at the beginning of a section of study. The learners should be informed that these criteria will be used to help assess their performance as the end of the unit.

The use of performance assessment is the most appropriate way to assess students when the purpose of instruction is generating a product or instilling the capacity to perform in some way (Cunningham, 1998, p.13). Performance assessment is thus ideally suited for the assessment of science in schools since science is inherently a practical subject and learning science is characterised by knowing and by doing science (National Assessment Governing Board, 2000). Performance-based assessment tasks require active engagement by the learners. Furthermore, it offers learners a wide range of options for communicating what they know by demonstrating their ideas, quantifying their results, making written, oral or visual presentations of their findings (Carin, 1997, p.123). Performance
assessment assesses science skills rather than reading skills, writing skills or content formation only.

Performance therefore, is a continuum of assessment formats, which allows teachers to observe or to listen to student behaviour ranging from simple responses to examining demonstrations of work collected over time. Airasian (2001, p.231) identified four domains of performance assessment:

- Communication, for example, writing an essay or following spoken instructions;
- Psychomotor skills, for example, setting up laboratory equipment or dissecting a frog;
- Concept acquisition, for example, identifying unknown chemical substances or constructing open and closed circuits; and
- Affective skills, for example, working in cooperative groups.

Performance assessment can be time-consuming and costly to develop, logistically demanding, and have questionable utility if not developed and scored according to sound measurement [assessment] methods (Quellmalz, Schank, Hinojosa, & Padilla, 1999, p.2). Teachers consequently are in need of appropriate knowledge and understanding of sound assessment practice. Moore (2001, p.282) identified the following features to formal performance assessment:

- Providing a clear purpose;
- Identifying attributes;
- Providing a setting; and
- Establishing the scoring.

These features will influence the competences expected of teachers to effectively assess the learners’ performances. Teacher competences for assessing performances, thus include:

- defining a clear purpose for the assessment;
- designing tasks that match the desired outcomes in the curriculum;
- generating and writing explicit and appropriate assessment criteria for each task;
• providing a setting to elicit and to observe the performance; and
• observing and interpreting learner performances.

The role and the status of the more routine teacher assessments in the GET band of the NQF have now become enhanced. This places an emphasis on the quality of the classroom-based assessments performed by the teachers. The characteristics of high quality classroom assessments are discussed next.

Wolf highlights the importance of the development of a common understanding regarding the concepts of performance assessment and how it links with continuous assessment, formative assessment and summative assessment (1995, p.67). Airasian (2001, p.236) reports that teachers are mostly ill-prepared at identifying the criteria that describes what makes a good task or performance since few teachers receive training in assessment during their training. The dilemma is that if teachers do not know what makes a good science project, how will they assess it fairly?

This places more emphasis on classroom assessment practices. Ensuring the quality of the evidence collected during classroom based assessment, is another general feature of the new approach to assessment.

2.3.6 Establishing high quality classroom assessments

As pointed out in paragraph 2.3.1, assessment is an essential part of instruction and high-quality teaching and learning is impossible without sound and credible assessment. Black and Harrison point out that research studies show that the everyday practice of assessment in classrooms is beset with problems and shortcomings (2000, p.32).

Although Airasian (2001, p.18) considers the ability to help the teacher to make correct decisions as the most important characteristic of good assessment, there is more to high-quality assessment than meets the eye. Classroom assessment looks at a sample of a learner’s performance or behaviour and uses that sample to make a generalisation about the learner’s performances on similar, unobserved tasks.
and behaviours. Any single assessment provides only a limited sample of a learner’s behaviour, and therefore no single assessment procedure or instrument can be expected to provide perfect, error-free information. The factors that will contribute to introducing some inconsistency into assessment information need to be identified and minimised as much as possible by the classroom teacher (Harlen, 2000, p.134).

McMillan (2001, p.52) points out that until recently, the quality of classroom assessment was determined by the extent to which specific psychometric standards of validity and reliability were met. He argues that since the purpose of the assessments in a classroom is different, these technical qualities have little relevance. He suggests that concerns about how the assessments influence learning and provide fair and credible reporting of learner achievement should be the focus in the provision of quality classroom assessment. Therefore, the focus is on the use and consequences of the results and what the assessments get learners to do, rather than on a detailed inspection of the test itself. Gipps supports this viewpoint and argues that the concern is with the quality of the performance and fairness in scoring rather than with replicability and generalisation (1996, p.123). McMillan (2001, p.52) summarised the arguments by stating that high-quality classroom assessments are assessments that are “technically sound and provide results that demonstrate and improve targeted student learning”.

Before this can happen, the targeted student learning should be defined and criterion referencing should be the system used as a basis for decisions on the demonstrated results of the learning. A decision that specifies the acceptable level of student performance should be taken before the assessment (Cunningham, 1998, p.47). The criterion-reference assessment therefore has the capacity to provide information about what a learner has learned.

The criteria for high-quality classroom assessment has been summarised by McMillan (2001, p.52) as being:

- clear and appropriate learning targets;
- appropriateness of assessment methods;
• validity;
• reliability;
• fairness;
• positive consequences; and
• practicability and efficiency.
These criteria were used to guide the analysis of the assessment practices of a sample of senior phase science teachers in Chapter 6.

The use of criterion referencing improves reliability since the use of a single, consistent system of clearly defined criteria ensures that the same standards can be applied in awarding grades. The quality of classroom assessments is consequently improved (Cunningham, 1998, p.47). The unique characteristic of criterion-referenced assessments is the ability to provide information about what a learner has learned. Gipps (1996, pp.254,255) states that criterion-referenced assessment looks at the individual as an individual and uses assessment constructively to identify strengths and weaknesses that individuals might have so as to aid their educational progress. Swain also supports this statement (2000, p.141).

However, it is important not to understate the difficulties in designing criterion-referenced assessment. The main problem is that, as the requirements become more abstract and demanding, so the task of defining the performance becomes more complex and unreliable (Gipps, 1996, p.18). Care is needed to ensure that teaching and assessment strategies based on the assessment criteria would not lead to breaking down a subject into isolated tasks. Another possible danger in the writing of assessment criteria is that there may be ambiguities in the criteria. The hierarchies of performance given by the criteria must bear a relationship to the learner responses to the questions.

In summary, the general features of the new approach to assessment: assessment takes place continuously with the purpose of collecting evidence to determine the learning progress during the learning process. The progress needs to be measured
against the standard of competency expected in a non-numerical, criterion-referenced manner. This gives rise to a term called “educational assessment” (Gipps, 1996, pp.245,255) that this study will adopt as the umbrella term that attempts to devise assessment which sees a learner as an individual rather than in relation to some other learner and to use assessment constructively to identify strengths and weaknesses that learners have that could aid their educational progress. Swain warns that some of the technical issues associated with all types of assessment, such as validity, dependability and reliability are often misunderstood (2000, p.141). These issues will be examined when looking at the policy documents for South Africa in Chapter 5.

2.4 TOWARDS DEVELOPING AN ASSESSMENT STRATEGY IN SCIENCE

There is a need to develop a science assessment strategy in which assessment features of new developments of both the South African and the international education systems are integrated in science in order to answer sub-question 1 of the research question.

Fairbrother (1991, p.153) highlights the importance of knowing what we are teaching before we can start assessing. It is also important to remember that assessment is a controversial issue in science education (National Academy of Sciences, et al., 1997, p.102). In order to infer the science assessment competence expected of senior phase teachers, the questions listed below need to be answered.

- What should be taught in the senior phase Natural Science learning area of the GET band?
- How should science in the senior phase be assessed in view of the new assessment approach?
- What are the implied competences within the context of an international and a South African literature review?

In order to answer the above questions, an assessment strategy needs to be developed in which the general assessment developments both internationally and
in South Africa are integrated. There is a need for consensus regarding desirable elements of science education against which learner attainment is to be assessed.

Petty (1993, p.352) identified aspects to which an assessment strategy should respond. He emphasised the importance, firstly, of relating the assessment strategy to the aims of the subject. The development of an assessment strategy, secondly, should clarify and respond to the purposes of the assessment, what is to be assessed and how it will be done. In developing the strategy, key reports in South Africa and South African policy documents were reviewed; local and international innovations in science curricula were studied and the science education literature was reviewed.

2.4.1 The aim of school science

The mission of school science is considered internationally as being the achievement of scientific literacy (Harlen, 2000, pp.11–14; Trowbridge, Bybee & Powell, 2000, pp.4,56). Harlen analysed different reform documents and concluded that, internationally, scientific literacy is considered to be the purpose of science in both primary schools and in secondary schools. Harlen (2000, p.14) points out that the achievement of scientific literacy depends on, but is more than, the acquisition of scientific knowledge, skills, values and attitudes.

In New Zealand the aim of science education includes the development of knowledge and understanding, skills and scientific investigation as well as the attitudes on which such investigations depend. All of these will happen within the major areas of science content (Life and Living, Earth and Beyond, Matter and Material, Energy and Change) as they are labelled in South Africa’s GET band.

Another viewpoint is held by Trowbridge, et al. (2000, p.57). They identified the vision of science in America as “science for all”, which carries the notion of equity. “Science for all” implies that all learners should experience the nature of science, the processes of science as well as its subject matter. Trowbridge and his fellow authors (2000, pp.56,57) point out that scientific literacy requires understanding concepts, processes and also understanding science as an integral part of society.
The emphasis on equity as being scientifically literate is also seen in related documentation on science education in Africa. Rollnick (1998, p.85) explicitly links equity and relevancy for Africa in the concept “science for all”, since the knowledge and skills needed to empower learners to control their lives must be relevant for Africa. Equity is further emphasised by Volmink (1998, p.74) who argues that school science in Africa should be relevant, meaningful, and not pursued simply for its own sake. The notion of lifelong learning incorporated in the critical outcomes of the NQF for South Africa links with Volmink’s argument of “science for life” as well as the specific outcomes of the Natural Sciences learning area in the GET band. A list of these outcomes is attached as Appendix A.

The aim of scientific literacy for the compulsory GET band in South Africa is reflected in the philosophy underpinning the Natural Science Learning Area in the senior phase of the GET band in South Africa, namely “science for all, science for life and science in service of society” (Eastern Cape DoE, 2000a, p.5). Since the NQF structure is such that the senior phase of the GET band spans both the traditional primary school (till Grade 7) as well as the secondary school (Grades 8 and 9), it is significant that the aim of science education is the same for both phases.

2.4.2 Purpose of assessment in science
There is a plea to affiliate assessment more closely with the purpose of science teaching. The curriculum, which comprises what should be taught, underwent change over the past decade. Trowbridge et al. (2000, p.57) emphasise that improvement of curriculum and instruction would be a hollow gesture without related changes in assessment at all levels. Changes in assessment must reflect changes for curriculum and instruction since “a good fit of assessment schemes with programme aims and teaching methods are considered an indicator of quality” (Knight, 1999, p.101).

Assessment should also increase the range of evidence used to evaluate learner achievement in order to ensure that learners apply science knowledge and
reasoning to situations similar to those they will encounter in the world outside the classroom (Trumbull, 1999, p.5).

Building on the general purposes of assessment discussed earlier in this chapter, Parkinson (1994, p.198) highlights the fact that assessment in science should have four main purposes. It should:
- assist in identifying strengths and weaknesses [diagnostic];
- assist and support learners in the learning of science [formative];
- provide information about progress and achievement of individual learners for themselves, for their parents and for a range of people [summative]; and
- assist science teachers in evaluating their teaching and learning programme.

Assessment should be context dependent, reflecting the nature of the subject matter. It is necessary, therefore, to discuss what constitutes learning in the science classroom, before we focus on the assessment of the learning.

2.4.3 The knowledge base of science
Although the various fields of science have their own special ways of knowing, the essentials of science at school should be defined for the purpose of planning appropriate assessments. Shepard (2000, p.8) points out that the content of assessment should match subject matter and serve to initiate what it means to know and to learn in the science disciplines and contexts. Airasian (2001, p.81) supports this view. He argues that learners should be able to deal with different forms of knowledge and emphasises that different types of knowledge often call for different types of assessment. Acknowledging this is of utmost importance for teachers planning for integrating instruction and assessment.

Trowbridge et al. (2000, p.70) support this argument and also suggest that scientific literacy includes:
- the acquisition of organised knowledge, which constitutes knowing about (Trowbridge et al., 2000, p.71) science;
• the development of intellectual abilities and manipulative skills, which constitutes *knowing how* (Trowbridge *et al.*, 2000, p.71) to do science; and
• the enlarged understanding of ideas and values, which constitutes *knowing why* (Trowbridge *et al.*, 2000, p.71) certain things are done as they are.

Although all three aspects are closely connected and learners use all three to respond to challenges of life, the overall aim of scientific literacy has to be broken down into component parts for the purpose of planning an assessment strategy that would enable the aim to be achieved. These component parts can be expressed in terms of scientific concepts, scientific process skills and scientific attitudes or in the words of Trowbridge *et al.* (2000, pp. 71, 72), *knowing about* science, *knowing how* to use science and *know why* science is used. Similarly in Mathematics, Ball (1991, p.7) identified two aspects of knowledge that address related aspects, namely, knowledge of mathematics as conceptual and procedural knowledge of the subject and knowledge about mathematics as “understandings about the nature of mathematical knowledge and activity: what is entailed in doing mathematics”. Airasian (2001, pp.81-82), reports three types of assessments displayed in teacher assessments: factual knowledge, conceptual knowledge and procedural knowledge.

Jegede (1998, p.153) argues that the knowledge base for science in Africa consists of the conceptual, the skills, the social and the resource domains. The conceptual domain is linked to learning within the accepted world-view, while the skills domain is concerned with the use of process skills. The social domain includes the communication used for reporting learning and working in social groups. In the resource domain, the learners should choose the most appropriate material for activities. The knowledge base for Africa, as Third World, therefore, is not different from that of the West, as First World. The identified domains for Africa’s knowledge base is closely related to the hierarchy of learning science, namely, the development from factual knowledge and practical skills to doing science, used in most western countries. Figure 2.1 illustrates the viewpoint of this study and will now be discussed in detail.
A knowledge base is an accumulation of information and of practices from which learners can draw in order to aid further learning. The four domains that comprise this knowledge base, namely, factual knowledge, conceptual understanding, procedural understanding and doing science, need to be addressed to make science learning relevant, possibly for Africa, but certainly for South Africa in particular. These domains will be integrated and discussed in detail so we may establish what needs to be assessed and how progression of achievement may be established.

Figure 2.1: A framework to illustrate the hierarchical integrated development of the knowledge base of science.

The first domain of the science knowledge base includes factual knowledge and practical and thinking skills or “knowing about” / “learning science” / “knowledge about” as discussed in previous paragraphs. The first component of the domain is **Factual knowledge**, which requires learners to remember facts in science.
Research shows that learning is knowledge dependent (Jegede, 1998, p.153) and that learners use existing knowledge to construct new knowledge. Cognitive research also highlights the importance of science content knowledge in thinking processes, all scientific inquiry or scientific debate (Harlen, 2000, p.14; Trowbridge et al., 2000, p.71; National Academy of Sciences, et al., 1997, p.17). "One cannot reason in the abstract; one must reason about something" (The National Academy of Sciences, et al., 1997, p.17). Factual knowledge thus constitutes one of the building blocks in the teaching of science as illustrated in Figure 2.1 and is an essential component of scientific literacy. Assessment strategies should thus focus on approaches that assess remembered information. Airasian (2001, p.194) points out that a defining characteristic of remembering factual knowledge is that learners cannot deduce or figure out the answer, but when the emphasis shifts to understanding and explanation, he classifies it as conceptual knowledge (Airasian, 2001, p.195), the second domain of the scientific knowledge base and discussed in a later paragraph. Leach and Scott (2000, p.42) further illuminate learning in science by arguing that ‘learning science’ involves understanding some of the ways of thinking, and the ways of explaining used in the scientific community. It involves coming to understand, and being able to use, the conceptual tools of the scientific community.

**Practical knowledge** constitutes the other building block (with factual knowledge) of the hierarchy of learning science and is considered as part of the first domain, namely, knowledge. The concept “practical knowledge” may be divided into three sub-categories, namely: cognitive processes (for example observe, classify, and hypothesise); practical techniques and inquiry tactics (Millar, 1991, p.51). In order to develop this practical knowledge component, opportunities to use the psychomotor skills, for instance, making observations, setting up apparatus, as well as intellectual and academic skills such as analysing data, communicating results, should be created (Trowbridge, et al., 2000, p.175). Thus, practical work should not be seen as only practical activities (Watson, 2000, p.69).

For the purpose of developing an assessment strategy it is useful to incorporate Airasian’s (2001, pp.81,82) further distinction between factual knowledge and
conceptual knowledge, although they are explicity linked. According to Qualter, et al. (1990, p.164), conceptual understanding is concerned with the concepts of science, the generalised ideas, such as magnetism and heredity. However, understanding conceptual knowledge requires learners to do more than just remembering the facts when answering the assessment item. Conceptual knowledge focuses on understanding and explaining. Trowbridge et al. (2000, p.71) explain conceptual understanding through inquiry skills and abilities. They identify the ability to construct scientific explanations, the recognition of alternative explanations, the use of the scientific processes and communication as the attributes that constitute the ability to inquire. This is closely connected to the concept of conceptual knowledge as identified by Airasian (2001, p.195). The assessment items selected for this assessment should thus be similar, but not identical to what was taught in order to prevent it from being a simple recall of factual knowledge (Airasian, 2001, p.195). If factual knowledge is “know-about” science, then conceptual knowledge is “know-how” (Trowbridge et al., 2000, p.71). In the conceptual knowledge domain, the learning outcomes should indicate that learners know how to do scientific investigations. The skills and abilities of this domain have very close connections with the domain of science knowledge outlined above since the knowledge domain acts as building blocks for conceptual understanding.

Procedural knowledge, the third domain of the science knowledge base in figure 2.1, comes into play if the narrow conception of practical exercises develops into investigations that are broader. Procedural understanding is described as an “understanding of how to put the specific practical skills together” (Gott & Mashiter, 1991, p.59). According to Qualter et al., (1990, p.164) procedural understanding is concerned with the identification of variables; designing an investigation so that the variables can be manipulated; the choice of judgements and the recording, display and interpretation of the judgements. On the one hand it involves having a concept or skill in drawing, and on the other hand it involves being able to use these understandings and skills with some purpose. These two need to be welded and to be used purposefully in a task to display procedural understanding (Kimbell, 1991, p.146). Millar (1991, p.51) points out that there would be progress in procedural
understanding in terms of the development of increasing competence in a wide range of practical techniques and an enlargement and extension of the toolkit of inquiry tactics as described earlier. Learners must have considerable practice before they can apply procedural understanding with confidence.

**Process skills** are considered to be the way of engaging with science content, using mental and physical skills common to most scientific content (Jegede, 1998, p.154). Consequently, process skills weld both conceptual and procedural understanding when used in investigative, problem-solving tasks (Gott & Mashiter, 1991, p.61). Evidence suggests that process skills are most appropriately taught in the context of investigations because the application of process skills is the result of an interaction of learners’ conceptual and procedural knowledge (Qualter et al., 1990, p.92). Process skills play a crucial part in the development of ideas, the making sense of new experiences in the future and for learning throughout life (Harlen, 2000, p.57).

Black and Atkin (1996, p.102), reported research that revealed the need for assessment to reflect science learning as involving the learning of exercises and procedures of scientific thinking. It should not be limited to memorising contents of a textbook. Learners should experience experimental practice. A science assessment should therefore include tasks that allow learners to demonstrate their skill in laboratory techniques and in using scientific thinking processes (Capper, 1996, p.53). Airasian (2001, p.122) identifies these different aspects of the applying and doing processes or procedures in science as procedural knowledge, which is a culmination of factual knowledge, practical skills and conceptual knowledge.

The third domain of scientific literacy is the willingness to use skills and to engage with content, which Harlen (2000, p.14) expresses in terms of attitudes and dispositions. In order to fully develop the aim of scientific literacy as explained in paragraph 2.4.1, the relationship between the knowledge basis of science and the attitudes and values mentioned by Harlen (2000, p.14) should be discussed. Trowbridge et al. (2000, p.72) place scientific literacy in the context of history, society and individual decisions. This component of scientific literacy engages
learners in content that provides meaning for science knowledge and intellectual skills. They argue that it is here that learners encounter the personal and social contexts of science [which will form the contexts for science investigations] that will allow them to recognise the ideas and values of science and further develop their own ideas and values. Trowbridge, et al. (2000, p.72) point out that the development of understanding occurs because learners have to use their knowledge and skills to respond to the proposed challenges of understanding science in their own lives, in societal problems, in historical contexts, and in different cultures. This third component constitutes knowledge of why science knowledge and skills should be learned (Trowbridge, et al., 2000, p.72) and, consequently, authentic assessment will be required.

Learning science is illustrated by the first developmental level in the teaching of science as illustrated in Figure 2.1, and it entails proceeding through the integrated aspects of conceptual knowledge, that is, with factual knowledge as building block, and procedural knowledge, that is, with individual practical skills as building block, necessary to complete the progression in science learning from level 1 to level 3.

The second developmental level in Figure 2.2 is represented by “knowing how” to use intellectual and manipulative skills, building on the foundation of the first level’s “knowing about” science. Learning about science can be linked to the attitudes expected from a learner of science. The learner needs experience of scientific activity as a basis for a thorough understanding of science, which will follow later in the development continuum. Learning about science will first start with developing attitudes of science, which support scientific activity and learning, after which the attitude towards science will develop. In order to have an “attitude towards science” (Harlen, 2000, p.18) it is necessary to have an idea of what science is. Therefore, the development of level 1 is essential for the development of level 2.

‘Doing science’ is learners identifying problems, framing questions, and working with the teacher to talk through and to develop possible solutions [that is doing investigations] (Leach & Scott, 2000, p.43). This represents the top level of the pyramid of teaching science for progression (see Figure 2.1). At this point it is
essential to realise that knowledge and process are interrelated and thus they cannot be completely separated one from the other (Qualter, et al., 1990, p.12). The building blocks would be developed by now and would be a matter of using the tools in ‘doing science’.

![Figure 2.2: An illustration of progression in scientific investigations.](image)

In any learning situation, concepts and procedures work together and the purpose of the task would indicate the balance between these two aspects in the task. This balance clarifies the aims and means of learning and the assessment tasks (Qualter, et al., 1990, p.15). The Knowledge of Science (level 1) provides the theoretical background needed to develop the desired dispositions needed (level 2) for the successful ‘Doing of Science’ (level 3). “If you want learners to acquire and to use intellectual skills and abilities they must have experienced doing investigations in science classrooms” (Trowbridge, et al., 2000, p.71).
The prevailing new philosophy of science teaching is that science is about discovery, and learners need to understand the process of this discovery. A science “test” or assessment should thus include tasks that allow learners to demonstrate their skill in laboratory techniques and in using scientific thinking processes (Capper, 1996, p.53). Competent science teachers, therefore, should be efficient in their understanding of science and their ability to assess hands-on and minds-on science. Different aspects of achievement offer different assessment opportunities. Skills relating to investigations can be assessed in many different
investigations and as a result, the opportunity for assessment will occur frequently (Harlen, 2000, p.154).

The range and variety of activities performed by learners in science make it necessary to use many assessment methods. Suitable means must be devised for assessing the progress and the achievement of learners in their laboratory experiences (Trowbridge, *et al.*, 2000, p.229).

The assessment of practical skills should be placed in a meaningful context. Black and Atkin (1996, p.102) support this when they point out that a project done in France suggests that if assessment is considered a tool to improve learning in science, then teaching science should be anchored in problems within the environment. Assessment should reflect that learning science includes the exercise of science thinking which is not limited to memorising contents of a textbook. Learners should experience experimental practice. In order to be effective, the science teachers, therefore, must enrich their lessons with elements of practical work to provide the learners with concrete and with practical experiences (Eniayeju, 2001, p.3). Assessment methods must be adjusted to match the newer teaching methods applied (Trowbridge *et al.*, 2000, p.306).

Learning is context sensitive. The implication is that teachers need to make decisions about the kind of science activities in which they want learners to engage. This has implications for the type of assessment to be used. The decisions need to be anchored to the view of learning and science required to underpin the teaching and assessment. This will guide the selection of criteria for the assessment planned and address the three domains of learning science identified as the aim of science teaching at school, namely, concepts, skills and attitudes. The aim of science assessment is to increase the range of evidence used to evaluate learner achievement to ensure that learners apply scientific knowledge and reasoning to situations similar to those they will encounter in the world outside the classroom (Trumbull, 1999, p.5).

In view of the above aspects of teaching science, the nature of science assessment should be performance-based assessment situated in a variety of
everyday contexts, such that both process and product are of importance. It should also integrate investigations, conceptual knowledge and understanding (Watson, 2000, p.62). One implication of a focus on performance assessment and the constructivist learning theory is that the curriculum should contain less material in order to ensure that learners have the time needed to develop deeper understandings (Trumbull, 1999, p.5). Consequently, teachers must make choices about what topics, concepts and factual information to address. The content of science in a particular grade continues to be an area of debate that represents an issue and a dilemma inherent in schooling. The different disciplines in science in the senior phase represent challenges for delimiting the curriculum since the disciplines are so complex.

This draws attention to the role of the teacher in the sense-making in science. These different understandings need to be assessed. Efficient science teachers should be competent in their understanding of conceptual and of procedural knowledge in science and able to assess hands-on and minds-on science learning.

Progress may be seen as hierarchical progression through the subject (Harrison, Simon and Watson, 2000, p.185). Progression and differentiation are intricately linked through the process of formative assessment (Harrison, et al., 2000, p.185). The authors explain that while progression puts in place the rungs of the curriculum ladder that the learner has to climb, formative assessment reveals to the teacher on which rung the learners are placed currently. It is essential that formative practices be utilised to construct and to drive the learning process (Harrison, et al., 2000, p.186). Progression in science can be seen as the ability to apply procedural and conceptual knowledge in increasingly broad contexts (Harrison, et al., 2000, p.184).

Matching problems to learners’ stages of development requires a model of progression based on the nature of problems and the approaches that can be used to investigate them. This practice requires an appreciation of learners’ levels of attainment. Progress can only be assured if learners’ learning is monitored. Ongoing assessment by teachers is essential if we are going to successfully match
learning experiences to the learners in the class. This approach is intended to be part of the teaching and learning process, rather than a bolt-on extra (Qualter, et al., 1990, p.6).

Assessment in science should allow learners to use their science process skills and content knowledge from the science disciplines in much the same way as they do in the science class. Assessment in science should mirror the science that is most important for students to learn. In order to achieve this a variety of innovative assessment methods are needed to bridge the gap between teaching and learning.

In summary: the nature of science assessment is performance based, in a variety of contexts, that both process and product are important and that it should integrate investigations, concept knowledge and understanding (Watson, 2000, p.62).

If assessment is seen as a means to identify the progress made and to help further progress to take place, the teacher needs to know the natural progress of a learner through the subject. This implies strong subject knowledge and understanding as well as subject pedagogical knowledge and understanding about the correct procedure for learner assessment (Cunningham, 1998, pp.8,9). Different learners will progress in different ways. Progression can be linked either to identifying what a learner does or the nature of the tasks (Fairbrother, 1991, p.161). Teachers need to be able to design assessment tasks that allow for a spread of attainment levels. Consequently, the science teacher also needs to be competent in exercising professional judgement in determining which assessment techniques suit the particular purposes of the assessment and that would document the progression.

2.5.1 Assessing conceptual knowledge
The scientific knowledge introduced in the school curriculum has particular characteristics. Recently, it has been recognised that scientific knowledge provides conceptual tools that allow people to describe and to explain how the world works with power and with precision and thereby achieve a richer understanding and...
appreciation of the world they experience (Knuth, Jones, Baxendale, 1991, p.1). If scientific facts, formulas, and definitions are presented as a body of content to be mastered, the result would be that learners would not attain conceptual knowledge. The assessment of conceptual knowledge therefore, should not assess science as atomistic facts, formulas and definitions as traditionally has been the case. It should be assessed while learners are engaged in experiences that require them to use scientific knowledge and processes as tools as they make sense of their experiences. Consequently, the assessment of conceptual knowledge should be focused on the extent to which both the factual knowledge of the learners and the skills they possess are used purposefully in a task (Kimbell, 1991, p.147). The USA Department of Education’s National Assessment Governing Board (NAGB) (2000) summarises this viewpoint by stating that mastery of basic scientific concepts can best be shown by a learner’s ability to use information to conduct a scientific investigation or to engage in practical reasoning. They also stress that an assessment of what learners know and what they can do must use techniques that reflect the nature of science.

A challenge in the design of assessment exercises is to capture changes in the characteristics of learner performance as learners mature. In the middle and high schools years (in which the senior phase of the GET band falls), the emphasis of assessment should shift to reasonable scientific interpretation of observations. The assessment should be increasingly concerned with the congruence of the learners’ interpretations with accepted interpretations, as well as with the sophistication of their reasoning in moving from observations of the natural world to explanations and predictions (NAGB, 2000, p.6).

Growth in conceptual understanding is enhanced by expertise in skill usage (Trowbridge, et al., 2000, p.224). A hierarchy of skills forms a framework to which concepts can be attached. In order to successfully develop the skills or process the goals in the science classroom, the assessment emphasis must be on performances, not on mere factual memorization or recitation. The superficial coverage of content should be de-emphasised and performance and depth of
understanding brought to the foreground (Trowbridge et al., 2000, p.225) through carefully selected assessments. There would be a greater need for the teacher to implement formative assessment in such scenarios than there would be in a traditional classroom where memorisation would play a significant role. Knuth, et al. (1991, p.2) report that research indicates successful teachers study their learners, learning how they think about the concepts they will study and armed with this knowledge they can formatively guide the learners through the complex and difficult process of conceptual change.

Concepts should therefore be applied in a variety of contexts provided by a variety of deliberately designed investigations, represented in a variety of ways, and then used in authentic assessment tasks since traditional tests are limited when it comes to highly valued aspects of conceptual understanding. Connecting learners work to the real world of their present experience and their future responsibilities is an effective means to improve conceptual understanding (Black & Atkin, 1996, p.69). The context of assessment tasks is of utmost importance and should be taken into account. Teachers should display the ability to ensure a relevant context for most of the learners.

2.5.2 Assessing practical work
Science is regarded as a practical subject (Woolnough, 1991, p.182; Christofi, 1988, pp.14-18) and to ignore this characteristic would be automatically to invalidate the overall assessment (Swain, 2000, p.152). A few decades ago assessments of laboratory work had depended on written testing. Little testing requires actual performance in a real or in a simulated situation that approaches reality. The assessment of laboratory skills, therefore, is new for South African teachers. Since practical activities or experimental science receives such a high profile in the newly defined learning area of Natural Science in the General Education and Training Band, the variations of experimental work and the accompanying assessment practices should be discussed in detail. Teachers are in a much better position to assess practical abilities fairly than a remote examiner marking a report of a practical experience. This highlights the level of responsibility expected of teachers, something about which they may not feel very confident.
Theory reveals that the assessment of laboratory skills is important for the teacher, in terms of assessing learner performance as well as providing important evaluative feedback (Woolnough, 1991, p.168). The laboratory is the place to learn the process of doing science (Trowbridge et al., 2000, p.222). Practical assessment provides information on learner’s skills and problem solving abilities through the use of apparatus setups, experiments, open-ended situations that can reveal certain thinking processes (Trowbridge et al., 2000, p.309). Both procedural and content aims are part of the core of practical science and they are inextricably related to one another (Watson, 2000, p.58). Woolnough and Allsop (in Watson, 2000, p.58) argue that different kinds of practical activity have different aims. Practical work may be divided into four types that all need to be assessed differently: individual skills (manipulation of apparatus); illustrations (following a set experimental procedure leading to a predetermined outcome), proving theory and investigations (Millar, 1991, p.51).

From the above distinction, it can be seen that the aims for assessment of practical work could include the aspects listed below.

1. Practical techniques (specific pieces of know-how about the selection and use of instruments and how to carry out standard procedures) need to be assessed. They can be seen as progressive, in terms of both increasing conceptual demand of certain techniques and increasing precision (Millar, 1991, p.51).

2. The use of cognitive processes (observation, classification, and so on.) should be assessed. Millar (1991, p.50) argues: “We are not teaching the processes, we are using them to develop conceptual understanding”.

3. Inquiry tactics that could assist when planning an investigation can be considered a “toolkit” of strategies and approaches.

The assessment of single skilled practical activities which is well defined and for which the criteria for success are clear, is easier because there is less freedom of choice for the learners. The teacher can construct the problem to obtain a more
clearly defined response, and so draw up a clear mark scheme (Fairbrother, 1991, p.154).

The question now arises as to how the teachers assess practical work. One approach would be to have a series of mini practical examinations. Another approach would be to assess pupils’ practical abilities during their normal practical sessions. The overriding decision between these two approaches must be based on what method gives the best picture of a pupil’s practical ability: monitoring the day-to-day practical tasks or using a practical examination?

A series of mini practical examinations has the advantage that testing can be carried out under examination conditions with no collaboration between individuals and, the outcomes could be seen as valid (Parkinson, 1994, p.215). Paper-and-pencil practical examinations or tests also have questionable validity. The test items are an indirect measure of the actual performance level or skills acquired in the actual laboratory setting. The teachers should develop measures to assess not only what the learner reports about activities in the laboratory, but also what the learner actually does in the laboratory (Giddings, Hofstein & Lunette, 1991, p.169).

In order to assess pupils’ practical abilities during their normal practical sessions has two major advantages: (a) it avoids putting pupils through the stress of an examination situation where they may not be able to perform to their normal standards; and (b) it can save laboratory time as no special occasion needs to be set aside (Parkinson, 1994, p.215). Parkinson (1994, p.215) identifies the following drawbacks that need to be considered when following this approach:

- the problem of maintaining standards over different lessons;
- the problem of the differing level of difficulty between practical tasks; and
- the problem of how to measure an individual’s contribution if pupils are working in groups.

In order to overcome the problems associated with both approaches, the teacher should first consider whether or not to assess the work by observing pupils carrying out their practical procedures (namely, process approach) or marking the product of their work, the practical report (namely, product approach). The written account
is generally the only tangible piece of evidence that the practical activity has taken place and is usually the principle factor in assessment. It is also the case that while pupils may work in groups on a task, they write it up as individuals each giving his/her own interpretation to the experiment. Parkinson (1994, p.216) provides evidence that the practical report alone cannot give a clear indication of the overall accomplishment of a pupil in practical work. A practical report will have no indication of the student’s ability to manipulate equipment, how accurately the measurements were taken, or how safely the pupil has worked. Written reports are often subjective because such variables as neatness, writing skills, volume and degree of completeness can bias an assessment (Giddings, et al., 1991, p.168). Parkinson concludes that although it may be difficult to assess pupils’ practical skills while they are performing the experiment it is vital that teachers take some note of what the pupils are doing. “To obtain an overall picture of a pupil’s ability to carry out practical work we must look at both the process and the product of the activity” (Parkinson, 1994, p.216).

The teachers should observe learners and listen to discussions taking place while learners are busy with their tasks. One way of monitoring the learners is to use a checklist of abilities you would expect to be demonstrated while learners are working. The process skills, attitudes and progression in the observation and discussion data could be “translated” into the subject matter of the particular activities being observed. This helps to focus the teacher’s attention on key parts of the practical rather than trying to make judgements on the activity as a whole. It also allows the teacher to focus on a sample of learners during one session and to repeat the procedure on other occasions using the same basic criteria. This approach to assessment should be administered as informally as possible. The suggestion is that the teacher makes brief notes from time to time as unobtrusively as possible. The performance of an operation or the verbalisation of a correct response is the area where assessment in science is difficult (Giddings et al., 1991, p.168).

Manipulative skills, observational abilities and more complex problem-solving and process skills can be assessed in actual laboratory situations (Giddings et al., Ixxiii
1991, p.169), making use of systematic observations based on a list of specific criteria.

In summary, Woolnough (1991, p.186) suggests the following systems for assessing learners’ activities in the laboratory:

- written evidence (reports or tests);
- practical laboratory examinations; and
- continuous observational assessment.

One of the characteristics of formative assessment in science, which has emerged from the discussion above, is that the lines are blurred between the assessment of written and the assessment by observation (Qualter et al., 1990, p.126).

Assessment of practical work and of investigations must be based upon the assessment of learners’ performances (Christofi, 1988, p.24). By defining grades via criteria, a more realistic identification of what learners can do will be possible. It is more reliable since it helps to standardised procedures. The implications are that teachers should be able to develop carefully planned curricula, which are related to science criteria.

Some general discussion of norm- and criterion referencing has already been presented in earlier paragraphs of this chapter. Criterion referencing enables the teacher to focus upon the performance of learners against a list of skill descriptors. This will lead to a more realistic identification of what learners can do, with the focus on internal assessment. There is a move towards the use of checklists, or at least grades with descriptors for the assessment of practical work. Capabilities need to be described in detail, not in a few words. Therefore, the competent teacher should possess conceptual knowledge, procedural knowledge as well as assessment knowledge in order to confidently choose the most appropriate assessment strategy for the assessment of practical work.

2.5.3 Assessing procedural knowledge and understanding
A skill is a specific activity that a learner can be trained to do, for example, manipulation of laboratory equipment. A process is a rational activity involving the application of a range of skills, for instance, processing of information. Qualter et al. (1990, p.164) define processes in the context of science education as the methods scientists use to investigate the natural world. Millar and Driver (in Watson, 2000, p.64) argue that processes only become scientific ones when being used for a scientific purpose. Traditionally, the skills required within science were called process skills since they are linked to the “scientific method” or the process of scientific thought (Christofi, 1988, p.22). Scientific procedures are skills and processes applied within a variety of different contexts (Watson, 2000, p.63) provided by the different types of investigations. Millar (in Watson, 2000, p.64) defined this ability to apply skills and processes in a variety of contexts as procedural understanding.

In other words, scientific processes and scientific knowledge and understanding are inextricably linked. Process skills applied with conceptual knowledge leads to procedural knowledge. Teachers, therefore, have to provide learners with the opportunity to develop process skills in a scientific context (Harlen, 2000, p.82). Assessment should foster the ability to transfer the skills and processes to other contexts. In order to make valid assessments of scientific procedures, the task should not put too low demands on scientific knowledge and understanding since procedural understanding is a knowledge-based domain.

Therefore, there is a need to design activities that progressively develop and refine learners’ understanding of the purpose of scientific investigation and of the key concepts, which underpin judgements about the quality of data. The learners should use scientific processes to carry out a practical activity, as well as understand the underlying concepts of evidence (Watson, 2000, p.65). Practical activities provide the channel through which a great deal of learning takes place (Harlen, 2000, p.82). Linked with social interaction, it helps learners to make sense of the learning and to make links between the ideas. Physical interaction is significant for learning science. Interaction opens up the possibility of explaining
things in terms of cause and effect. This highlights the importance of social interaction as an important consequence for organising practical work.

A teacher needs to know how to validly describe the processes that are used in solving a problem in order to map the assessment closely onto these descriptions. As assessment moves towards criterion-reference approaches, the involvement of learners in the assessment process becomes more important. The criteria for attainment and progression should also be made known to the learners (Fairbrother, 1991, p.160). Curriculum 2005 with its strong emphasis on criteria and progression makes this even more imperative.

Assessment of process skills should occur through direct observation, and probably only by the teacher (Christofi, 1988, p.22). A written report based on practical work can be valid but Christofi warns against the overemphasis on neatness, on writing skills and on the volume of practical work. Reports cannot provide direct information on skills in manipulating equipment, observing and performing an investigation efficiently. A combination of written reports, checklists, questions and impression grading provides an accurate picture of practical work done as part of the teaching of a topic. The activities must be assessed as the teacher observes the learner at work. A checklist of points may be used. This provides systematic, direct observation of scientific behaviour. Checklists also enable a teacher to pinpoint more readily, student weaknesses, ineffective instructions or problems with a worksheet.

For practical skills that have a broader basis, a detailed, closely defined checklist is less useful. Manual dexterity, for example, involving the rapid and confident completion of tasks, lends itself more to an impression mark on a 5- or 10-point scale (Christofi, 1988, p.22). Product skills may be assessed in a variety of ways. The products of practical work may be presented in a number of different ways, for example, diagrams, tables, written accounts, answers to questions or a completed dissection. Here checklists of points can be prepared in advance and applied.

Qualter et al. (1990, p.123) believe that the assessment of learners' class work can be done in two ways: by observing the learners as they work and by scanning the
work they produce. The learners’ written work can be the primary source of information about their progress. The assessment made of the written work will be of most use if it communicates to learners how well they have achieved certain aims, where they need to re-think something, or what they need to concentrate on next time (Qualter et al., 1990, p.124). By implication, the teachers need to have a clear idea of what they are looking for (Qualter et al., 1990, p.125), which is only possible if it is underpinned by strong subject knowledge.

Many of the important aspects of performance can only be assessed by direct observation of the learner (Qualter et al., 1990, p.125). Observation involves watching learners work and then discussing their ideas with them. One of the characteristics of formative assessment is that the lines between the assessment of written work and assessment by observation are blurred. For example, difficulties in understanding written work lead a teacher back to the learner, where the assessment is by observation. It is important to make explicit what is valued and therefore be clear about what is being sought. The teacher needs to consider both what is possible to assess and what is worthwhile to assess (Qualter et al., 1990, p.128).

Wile performance assessment refers to the type of student response being assessed (Victor & Kellough, 1997, p.222); authentic assessment refers to the assessment situation. For the assessment in science to be authentic, it should assess the student’s understanding of that which the student has been learning: you would use a performance-based assessment procedure.

2.5.4 Assessing investigative work
Fairbrother (1991, p.156) argues that the assessment of practical skills should be put into some kind of meaningful context. The application of process skills is the result of an interaction of learners’ conceptual and their procedural knowledge (Qualter, et al., 1990, p.92). One needs to know what makes a task procedurally simpler or complex – the context? The context carries a pattern of understandings and experiences: it provides the meaning for the task. This context involves investigation or open-ended problem solving, which for the purpose of this study, is
treated as synonymous. The assessment of individual skills should therefore take place in the context of investigations, not as isolated skills.

Assessment requires that there should be some model of what we think the student should be doing. It is important for the learner and teacher to be clear about what aspects are being encouraged and thereafter, what to assess in “doing science” (Woolnough, 1991, p.182). Woolnough points out that it is only when the skills and processes of science are developed in the context of “doing science” that they acquire any scientific validity. For Qualter et al. (1990, p.128) the assessment of investigations, therefore, is the assessment of procedural knowledge and not just individual skills.

Gott and Murphy (in Fairbrother, 2000, p.158) support this view and identify conceptual understanding, which is concerned with facts, concepts, laws and principles, and procedural understanding, which is concerned with how science is used to solve problems, as requirement for investigations. Consequently practical investigations as the culmination of procedural and conceptual understanding need to be at the heart of science teaching and assessment.

The primary aim for investigations is to develop the use of the procedures of science (Watson, 2000, p.62). A secondary aim is teaching for conceptual understanding and a third possible aim is to develop the learners’ understanding of the relationship between empirical data and scientific theory (Driver in Watson, 2000, p.62). Learners should therefore be assessed on how to apply conceptual understanding efficiently in the design and the execution of scientific investigations and in practical reasoning.

Investigations differ from other types of practical work in a number of ways and for that reason the assessment of it is unique in the following aspects:

- it is more mentally taxing and as such the assessment should focus on higher order cognitive skills;
- it is more than just the carrying out an experiment to be assessed;
- it requires the pupils to plan their own experiments;
• it requires pupils to evaluate their experiments and suggest improvements - a component of self-assessment needs to be included;
• it encourages pupils to question their own understanding of scientific phenomena; and
• it encourages pupils to search out information for themselves rather than relying heavily on the teacher.

During investigations, learners employ many different skills:
• Psychomotor skills – such as doing something physical such as making observations, setting up apparatus, and so on; and
• Intellectual or academic skills – such as analysing data, communicating results (Trowbridge, et al., 2000, p.175).

But the assessment of investigative work should not result in an artificial separation between experimental or investigative work, and the knowledge and understanding components of the curriculum. The implication is that learners need to be able to use the instruments, as well as know when to use them. Investigation skills need to be assessed in the context of a whole investigation. Woolnough (1991, p.184) argues that holistic assessment of the investigations is more advantageous than an assessment framework that reduces the whole to a series of measurable parts. The process of scientific investigation is as important as any product or result that the pupils may obtain from their experiment (Parkinson, 1994, pp.106,107). It is vital that the learning structured around investigations starts with separate activities to learn the scientific procedures, but culminate in whole investigations that provide a context and a scientific purpose (Watson, 2000, p.65).

Watson (2000, p.63) also points out the necessity of providing a variety of experiences, when designing investigations. Through research, Swain (2000, p.153) concludes that learners should be given experience of investigational practical work in a variety of scientific domains rather than in a single domain.

When focusing on scientific skills and processes, assessment tasks should not make low demands on learners’ knowledge and understanding (Watson, 2000,
For pupils to make progress with their investigative techniques, they should be provided with tasks of increasing complexity (see figure 2.2). There are two key areas of progression to consider:

- the complexity of the task set by the teacher, and
- the approach a pupil uses to tackle an investigation.

The progression in terms of task complexity will have increasing difficulty in terms of the context in which the investigation is set, the procedural demands of the investigation and the conceptual demands of the investigation (Parkinson, 1994, p.129). Progress is to move from a closed or focussed investigation to an open or explorative investigation with less support provided by the teacher. A closed investigation may be defined as one where there is a single way of approaching the task, whereas an open investigation can have multiple solutions or one solution with many approaches (Parkinson, 1994, p.116). Open investigations do not have a recipe-type, step-by-step procedure available for conducting experiments. The learners have decision-making power over what to investigate and how to investigate with-in the constraints of available resources. In more closed investigations the learners may need or receive support from the teacher (Harrison, et al., 2000, p.182). Open investigations place more demand on procedural and conceptual understanding (Harrison, et al., 2000, p.184). This complicates the assessment since the criteria need to take all the possibilities or the flexibility of the approach into account.

The second key area of progression in investigations involves the approaches of the learners to carrying out investigations. Watson (2000, p.65) identified that learners respond in one of four ways to investigations and that the points indicate a progression in the understanding of investigations:

1. Engagement frame: they are engaged without an obvious plan or purpose;
2. Modelling frame: they try to produce a desired effect;
3. Engineering frame: in which they try to optimise the effect; and
4. Scientific frame.

Parallel to the increase in complexity of the task set for assessment purposes, a longitudinal assessment of the responses by the learners’ needs to be done to
report the progress of the learners in achieving conceptual and procedural understanding of investigations.

Investigations will vary in many aspects, but they will each have the same structure. They will all start with a problem, which is then turned into a manageable task and a scheme of work is planned. Then the plan will be executed with the apparatus selected, measurements taken, observations made and results recorded and interpreted. The conclusions will be reported in an appropriate manner. In investigative work, learners are involved in the process of finding out things by enquiry. This will involve experimentation but it will also require the learner to search for information in other ways. Through investigations, learners work in a scientific way to solve problems and so gain knowledge and understanding (Watson, 2000, p.115). Investigations can be considered a type of practical problem solving process which brings together learners’ conceptual understanding, scientific skills and processes to solve a problem (Trowbridge, et al., 2000, p.212; Watson, 2000, p.62). This can represent development level 3 in Figure 2.3.

An investigation comprises several stages, each with its own discourse. The discussion that permeates the stages of the investigation itself needs to continue into its write-up. This will allow cognitive links to be made between the actual event, the informal talk about the event, and the formal recording of it (Jones, 2000, p.101). The written account is generally the only tangible piece of evidence that the practical activity has taken place. It is usually the principle factor in assessment and consequently may show (or may lack) the connections made. In investigations, Jones suggests that learners should write something during each stage of an investigation and not just the final one, since writing the report is an integral part of a process during an investigation rather than the final activity. Learners are encouraged to reflect on the experiences of the investigation, naming it an experiential as well as coherent event (Jones, 2000, p.101).

There are two means of assessing investigations: observing learners as they work and by looking at the work, they have produced. The basic principles of practical
assessments, such as using a combination of observational, oral and written techniques, are just as appropriate for assessing investigative work.

There is a difference in the way that an investigation is carried out in contrast to the methods used for traditional practical exercise. The practical work route involves pupils following instructions supplied by the teacher, but with the investigative approach, the pupils are following their own plans. When learners are required to make decisions for themselves without being told that the initiative of planning and monitoring their learning has been passed on to them and without them having been educated in decision-making, many investigations in science descend into chaos (Fairbrother, 2000, p.12). As the pupils will not be following tried and tested routines in their investigations there is a greater likelihood of them requiring support from the teacher. This may mean that teachers will have to consider how they are going to allocate their time during the lesson.

For extended project work to encourage the development of learning strategies essential for life-long learning, it needs to be properly planned and managed. Criteria for the evaluation of learning must be developed with learners so they learn to think and ask questions of themselves as they proceed through the learning activity (Fairbrother, 2000. p.12). Planning for formative assessment opportunities is just as essential to serve as signposts in the learning process for both the teacher and the learner. Formative and summative assessment may be balanced by the identification and planning of sections for providing support and other sections allowing learners to make decisions. The support can be structured in the lessons. Parkinson (1994, p.217) points out that if pupils are successful in the planning part of the process they will be successful in the implementation of the plan and, therefore, may not need much help.

In order to assess investigations, there should be some model of what the learners should be doing, built into the teacher’s mind. This implies having sound content knowledge. The teachers need to define ‘criteria’ which are involved in each stage of an investigation. The implication is that teachers should understand the evidence generated and they should also be able to formulate clear and explicit
criteria that are appropriate for the particular level of development. A high level of communication skills is crucial to achieve the expectation. The need for clear and explicit criteria when assessing investigations is evident from research. The teacher should also be able to formulate clear and explicit criteria that are appropriate to that particular level of development. Teachers also need a clear understanding of the complexity of each problem to be tackled by the learners. Consequently, they need to know about progression in problem solving activities and they need to plan for progression (Parkinson, 1994, p.129).

This chapter placed the assessment of science against the backdrop of developments in general assessment practices. Since it has been established that the aim of teaching science is to educate learners to be scientifically literate, the domains of being scientifically literate were identified and the assessment thereof discussed. The next chapter will explain the research design to show how I went about my data collection.
Chapter Three
Research Methodology

3.1 RESEARCH OUTLINE
This chapter aims to place the research within a particular paradigm, which will determine the approach used. The reasons for choosing a case study will lead to an elucidation of the research design. The research process focuses on each of the research questions together with the tools used to answer them, which in turn leads to a discussion of the problems that were experienced.

3.2 PHILOSOPHICAL BACKGROUND
Empirical inquiry is shaped by paradigm commitments and by the recurring questions that any given paradigm, or interpretive perspective, asks about human experience (Denzin & Lincoln, 1998, p. xi). These authors believe that the world is confronted through the lens of the researcher’s paradigm and as specific investigations are planned and carried out, two issues must be confronted: research design and choice of strategy. The research design situates the investigator in the empirical world while the strategy of inquiry comprises the skills, assumptions and practices used by the researcher when moving from the paradigm and a research design to the collection of empirical materials. What follows is my position in terms of the research methodology.

3.2.1 Qualitative research
The focus of this study is on the assessment competence expected of senior phase science teachers as a result of the implementation of an outcomes-based education system in the General Education and Training (GET) Band of the NQF. The purpose of this research is to understand science teachers’ assessment competence and the social contexts within which they function. The inquiry should penetrate the surface in order to seek what Geertz (in Eisner, 1991, p.35) calls a “thick description”. The thick description is needed to provide a framework for the development of an instrument that could be used for the further development of the competencies through a training programme for senior phase science teachers. This goal namely, understanding the phenomenon of classroom based science
assessment, is likely to be lost as soon as textual data are quantified (Kaplan & Maxwell, in Myers, 1997, p.2). Consequently, this research is located in the qualitative research field. Denzin and Lincoln (1998, pp. 3-9) define qualitative research as “multi-method” in focus and involving an interpretive, naturalistic approach to its subject matter.

3.2.2 Paradigms and approach

All research is based on some underlying assumptions about what constitutes “valid” research and which research methods are appropriate. This “net of epistemological, ontological, and methodological premises” may be termed a “paradigm” (Guba, 1990, p.18; Cresswell, 1998, p.74) or the “interpretive framework” (Denzin & Lincoln, 1998, p.26) of the research.

This study assumes a relativist ontology with multiple socially constructed realities that is complex and continually changing. As researcher, I am the primary gatherer and interpreter of meaning and the interpretive epistemology allows me to interpret constructions through a naturalistic set of interpretive methodological procedures. Furthermore, classrooms are complex social situations where teachers, learners, and researchers are constantly constructing meaning (Gudmundsdottir, 1999, p.177). These above mentioned assumptions reflect the constructivist-interpretive paradigm (Denzin & Lincoln, 1998, p.27).

Ethics is intrinsic to this paradigm because of the inclusion of participant values in the inquiry (Guba & Lincoln, 1998, p.215). The whole process of the constructivist paradigm tilts towards revelation. The close personal interaction required by the methodology of this study may produce special and often sticky problems of confidentiality and anonymity, as well as interpersonal difficulties (Guba & Lincoln, 1998, p.215). The research design should address aspects of confirmability, transferability and dependability to ensure rigorous data collection and data analysis.

This assumption regarding the nature of the world affects not only the research approach, but also the purpose of the research and the roles of the researcher.
(Glesne & Peshkin, 1992, p.6), as is discussed in further paragraphs. Guba and Lincoln (1998, p.209) add that the paradigm choice has important consequences for the practical conduct of the inquiry, as well as for the interpretation of the findings. It is because of this interpretive stand that I have chosen to write the rest of this study in the first person rather than the third person.

This study describes the assessment practices of a sample of senior phase science teachers. The nature of this focus suggests that a descriptive research approach would be more appropriate than one that is explanatory. My study involves describing and summarising details of the process of science-assessment and the accompanying competence expected of teachers to gain insight into this phenomenon. Therefore, it has an ideographic or particularising bias that is supported by a descriptive approach to research (Punch, 2000, p.38).

Since descriptive research sets out to collect, organise and summarise information about the matter being studied, Punch (2000, p.38) argues that a descriptive emphasis is appropriate for a new research area where descriptive information does not exist. Very little is written on the science-assessment competence needed by teachers in South Africa. The introduction of the NQF and the implementation of Curriculum 2005 (C2005) are also fairly new developments, first introduced in January 1999 for Grade 7. This highlights the need for a description of the science-assessment competences of senior phase teachers before explanatory research can be done in a follow-up study.

Having decided on a qualitative approach, the next consideration was to identify the intended audience for the research in order to find “forms of reporting and styles of presentation that easily enter the natural language, dialogue and styles of thought” of the intended audience (Walker, 1985, p.87). The intended audience for this study includes education policy makers, teacher educators, the Department of Education’s Education Development Officers, as well as teachers. This represents a broad variety of stakeholders with whom the researcher needs to communicate the value and the usefulness of the study. A qualitative approach therefore would provide the most appropriate reporting style for the natural dialogue of the intended
audience. The types of narration used were the interpretive case study and ethnographic description (Denzin & Lincoln, 1998, p.27).

3.2.3 Role of the researcher

By opting for the descriptive approach, the researcher is the key instrument of data collection, as the researcher approaches the research situation with a “set of ideas, a framework (theory, ontology) that specifies a set of questions (epistemology) the research problem is consequently examined (methodology, analysis) in specific ways” (Denzin & Lincoln, 1998, p.23).

The role of the researcher in the interpretive paradigm involves interpreting the actions of those who are themselves interpreters, for example the teachers have to interpret policy documents before they implement it. In this study, I will analyse the teachers’ interpretation of the assessment policy for science through their assessment actions in their classrooms.

Although qualitative researchers are generally committed to an emic, that is an insider, and an ideographic, that is a case-based position, (Denzin & Lincoln, 1998, p.10), I adopted the role of a “non-interventionist” (Punch, 2000, p.53) interested outsider. The focus of the research is to describe the assessment competence of science teachers as observed in their natural settings. The description of the science-assessment competence of the teachers needed to be as unbiased and as free from researcher influences as possible; therefore it was not desirable to be a participant insider. For this reason, a heuristic and descriptive approach was followed, employing a case study with an ethnographic angle as the naturalistic set of methodological procedures.
3.2.4 Purpose of this research

The focus of this research is to gain insight into the larger phenomenon of science-assessment competence through the intensive study of a sample of science teachers and not to indicate relationships that exist or provide an explanation for the assessment practices of science teachers. In order to gain this insight the research studies the phenomenon of science-assessment competence in detail, and in context, focussing on interpretations and/or processes of science assessment practice.

3.2.5 Goals of the research

This study looks at the assessment practices of senior phase science teachers in order to gain a better understanding of the following:

- The ways in which a sample of three senior phase teachers assess science in the General Education and Training Band.
- The assessment competences needed for effective science assessment in South Africa.
- The result of combining what exists with what is needed in South Africa.

In attempting to achieve the above-mentioned goals, an analysis of the international and the South African literature on the effective assessment of science was done. The framework that will emerge out of Chapter 5 will be used to theorise around the classroom assessment practices of the teachers observed and described in Chapter 4.

3.3 Research design

A research design describes a flexible set of guidelines that connects theoretical paradigms, in this case constructivist – an interpretive paradigm, to strategies of inquiry, in this case ethnographic case study, and methods for collecting empirical material, examples of the latter being non-interventionist observation, interviews, and document analysis regarding assessment in science classrooms. In this study, the research design consists of an ethnographic case study as inquiry strategy with non-interventionist observation, interviews with the teachers and document analysis of the policy documents published by the national DoE and assessment artefacts developed by the teachers and the learners as their data collection.
methods. The inquiry strategy and issues that could pose a threat for the data collection and the research process will be discussed in more detail.

3.3.1 Strategies of inquiry/research method

This research consists of three distinct parts. Firstly, the classroom assessment practices of a sample of three science teachers were observed, interpreted and described. Secondly, the policy documents of the national DoE were analysed and compared with internationally accepted trends in good science assessment practices that forms part of the literature review. This describes to describe the assessment competences expected of senior phase science teachers. Thirdly, the practical real-life contexts as revealed by the teachers’ assessment practices would be linked to theories to enable me to investigate the need or not of an instrument to determine the science assessment competence of these senior phase teachers.

The focus of the classroom observation was on the culture of science assessment in the schools. Since the culture of science assessment cannot be observed, it could be inferred from the patterned way of deciding what is important; from determining the assessment activities; and from recording assessment results and reporting assessment results. The culture of assessment in the different classrooms would be interpreted and then described. According to Wolcott (1988, p. 202), ethnography is well suited to answer the question: What is going on? It has been claimed to represent a uniquely humanistic, interpretive approach to research. Thus, Ethnography is a good strategy for this study, especially because it is the nature of research description and interpretation that makes the research ethnographic, not so much the methods employed.

The ethnographic angle, consequently, will provide the in-depth understanding or “thick description” (Geertz in Eisner, 1991, p.35) of the teachers’ science-assessment practices in the broader context within which they work. The strength of adding an ethnographic angle to the description relies in its triangulation of data sources and methodology (Denzin in Janesick, 1998, p. 46). However, to achieve this it is essential to spend sufficient time in the field to ‘see’ a full cycle of events. I
observed a learning unit over a period in the classroom to see all the different aspects of science assessment practices employed as well as to verify earlier observations in order to describe their assessment practices. A case study is a suitable methodological choice for a descriptive, heuristic and inductive study (Rossman & Rallis, 1998, p.70).

Although there are numerous definitions for a case study, Yin (in Myers, 1997, pp. 6, 7) defined the scope of a case study as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident”. Since the goal of a case study is to understand a larger contemporary phenomenon [such as science assessment practices] through close examination of a specific case, it is useful for rich descriptions (Rossman & Rallis, 1998, p.70). The study attempts to illustrate the complexities of science assessment practices in a sample of schools from different perspectives in order to contribute to the creation of a full contextual understanding of the assessment practices of senior phase science teachers. Rossman and Rallis argue that “by providing detail and complexity, case studies illuminate the reader’s understandings of the setting and the event, thereby extending comprehension of some complex sets of events or circumstances” [such as assessment practices] (1998, p.70).

Cases are used for different purposes in educational research and are selected for what it can tell the researcher in terms of research questions posed (Hitchcock & Hughes, 1989, p.320). The interpretive case study chosen for this research is used to develop conceptual categories and give rise to meanings; [for instance, about teachers’ assessment competence] that are difficult to attain in any other way (Carter, 1999, p.171).

Another reason for employing a case study as a strategy of inquiry is the focus on describing the social phenomenon of assessment in reality. It is therefore likely to appeal to practitioners, who will be able to identify with issues and concerns raised (Walker & Adelman, 1976, p.72). Case study data are usually more accessible than conventional research reports, and therefore capable of serving multiple
audiences. This research will move from the reality observed to the need for the development of a training course that has as its aim the change and the improvement of teachers’ assessment practices.

The science assessment practices illustrated by the observation of the collective sample of three cases (2 cases of Grade 7 teachers and 1 case of a Grade 8 teacher) will provide a lens on the phenomenon of science assessment competences in a South African context. This insight can then be used to understand the larger collection of cases – that of science teachers in the Eastern Cape region. One can generalise from a case either about an instance, or from an instance to a class. It can represent a multiplicity of viewpoints, and can offer support to alternate interpretations. Properly presented case studies can provide a database of materials. In this case study, the database would be the assessment competence framework for science-assessment, which may be re-interpreted by future researchers. The insights yielded by case studies can be put to immediate use for a variety of purposes, including staff development, intra-institutional feedback, formative evaluation and educational policy-making.

The concern is not merely with a description of what is being observed, but to search for recurring patterns and constant regularities. In discerning these patterns, triangulation is frequently used. The classroom observations and the in-depth interviews after the observations may establish recurring patterns and constant regularities of science-assessment competence displayed by teachers.

For this reason, a heuristic and descriptive approach, employing a case study with an ethnographic angle as the naturalistic set of methodological procedures, was followed. Yin (1984, p.13) has argued: “case studies are the preferred strategy when “how” questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context”.

A case study with an ethnographic angle will use ethnographic data generating techniques to provide descriptions and interpretations of the science assessment
practices of the sample of senior phase science teachers. It involves multiple means of gathering data as an attempt to build an in-depth picture of the case (Cresswell, 1998, p.123). This will justify the complexity of the study and consequently contribute to the trustworthiness of the data with increased rigour. In order to ensure rigorous data collection and data analysis, the potential threats for effectiveness of data collection first need to be addressed.

3.3.2 Issues in research design/methodology
3.3.2.1 Confirmability: the concern for the truth

The need for triangulation or validation of research evidence arises from the ethical need to confirm the validity of the processes (Tellis, 1997, p.7; Denzin & Lincoln, 1998, p.4; Stake, 1998, p.97) since the validity of a case study is more important than its reliability. As an alternative for reliability and validity, Guba and Lincoln (in Bassey, 1999, p.75) used the concept “trustworthiness”. This illuminates the ethic of respect for truth in research. Validity in the qualitative arena has to do with the credibility of the description (Janesick, 1998, p.50) of the research. In order to reduce the likelihood of misinterpretation by the researcher, various procedures may be employed, in a process called triangulation.

My study included data triangulation (namely multiple sources of evidence) and methodological triangulation (namely multiple ways of collecting the data) as strategies to provide multiple perspectives of the investigation to provide a more honest reflection of reality. The data in this study were collected by non-participant observation of the teachers’ classroom assessment practices, interviews with the teachers, and the analysis of the assessment documents produced by the teachers.

Since case studies have a tendency to spread the net for evidence more widely (Hitchcock & Hughes, 1989, p.321), I observed the teachers’ classroom practices over a period of time. I decided that in order to construct a rich, coherent and useful interpretation of assessment within a classroom, it was important for me to “see” the whole story of a teaching unit. This would allow me to become familiar with the context of the learning within the particular classroom for the particular
unit. I would be present throughout the planned and then delivered unit of work and would observe the learners’ interactions and meaning-making throughout the unit. Such continuity is important for naturalistic research where the researcher wishes to develop a valid interpretation of a complex process (Bell & Cowie, 1999, p.205).

For this purpose, the two primary school teachers and one secondary school teacher were observed throughout their units of work in 2000 and 2001 and data were collected and recorded via a variety of techniques, thereby providing a “chain of evidence” needed to confirm these descriptions.

Another aspect that leads to confirmability of research data, is the saturation of data collection that occurs (Hopkins, 1993, p.154). This is where no additional data are found that may develop properties of the category. All three teachers had more than one class for the same grade. The lessons that I observed were as a result presented to more than one class group. This provided ample opportunities for me to observe the same lessons presented by the same teachers, but to different classes, for instance School 2 had seven classes taught by the same teacher. This provided the saturation of the data collection needed for the establishment of the “chain of evidence”.

3.3.2.2 Generalisability: the concern for applicability or transferability
External validity examines the extent to which the result of the study can be generalised beyond the immediate case to the real world (Tellis, 1997, p.6; Bless & Higson-Smith, 1995, p.82; Bassey, 1999, p.75). Applicability indicates the extent to which the findings apply to other people and other settings. A frequent criticism of case study methodology is that its dependence on such small sample groups renders it incapable of providing a generalising conclusion. Yin (in Tellis, 1997, p.3) believes that general applicability results from the set of methodological qualities of the case, and the rigor with which the case is constructed. Tellis (1997, p.6) argues that case studies have analytical generalisations where the researcher strives to generalise a particular set of results within some broader theory. This is endorsed by Myers (1999, p.7) who cites Yin’s viewpoint that generalizations are made to theory and not to populations.
In this research, the science assessment practices of the sample of teachers would be applied to the framework emerging from the literature study done to identify the competences associated with the general trends in good assessment practice globally as well as the particular competences associated with science assessment. Myers (1999, p.7) citing Walsham and Yin, argues that as it is possible to generalise from one case to theory, it is possible to generalise from one ethnographic study to theory. The arguments made in favour of generalisation from case studies apply equally to ethnographic research.

Vital to this research is that the case study is linked to a firm theoretical base. This ensures some transferability from the local Eastern Cape cases observed in this research to the South African context in general (Tellis, 1997, p.3), providing that the research is open and explicit so that people reading it can relate it to their own needs and situations.

Furthermore, the whole issue of generalisability in the naturalistic research tradition focuses on the contribution that this in-depth understanding of real-life classrooms could make to illuminate issues for other people. Consequently, this research does not claim that the results of this study should be true for all teachers in general, but some transfer may be possible provided that the reader can relate it to their situations by seeking parallel applications their situations.
3.3.2.3 Reliability: the concern for consistency
Reliability is the measure of the extent to which the operations of a study - such as the data collection procedures - can be repeated with the same result (Yin, 1984, p.45). The aim of reliability is as a result to eradicate researcher bias in the study. In the interpretive research paradigm, it is highly probable that a different researcher would have a different interpretation of the same events observed. By making the research as open and explicit as possible I tried to overcome the problem of reliability without damaging the essential nature of interpretative research.

In addition, I needed to ensure that the respondent teachers express what they perceive as reality, rather than what they wished reality to be (Bless & Higson-Smith, 1995, p.109), what they thought it ought to be, or what they believe to be the best answer to satisfy me. This aspect will be addressed in the paragraph addressing the problems experienced during the collection of data for the classroom practices of the science teachers.

3.3.2.4 Ethical considerations
Ethics is intrinsic to the constructivist paradigm because of the inclusion of participant values in the inquiry (Guba & Lincoln, 1998, p.215). The close personal interactions required by the methodology produced sticky problems of confidentiality and anonymity, as well as interpersonal difficulties (Guba & Lincoln, 1998, p.215). Access and acceptance made these problems greater as a result of the relationship that qualitative fieldwork expects from the researcher and the researched (Punch, 1998, p.158).

Access and Permission
Schools are organisations that have a definite power structure (Hitchcock & Hughes, 1989, p.39). The relationships in schools make access and entry to the research situation complex and often problematic. Added to the presence of a power structure the nature of the research, in this case the very sensitive aspect of teachers’ assessment practice, may also be a contributing factor for the refusal of access (Punch, 1998, p.163). Unfortunately, the phenomenon of classroom
assessment practice has a political implication for most teachers in South Africa. Seen against the background of South Africa’s apartheid history where school inspectors were not allowed into all school classrooms, where there is still mistrust by school communities of researchers that use the schools for their own benefit and then leave, I expected my presence to trigger conflict between the demands of policy and those of professional practice. Informed consent was received from principals and teachers involved. I disclosed my identity and research purpose to them since my institutional background facilitated access to these schools.

Anonymity and Confidentiality
Walker (1985, pp. 23-26) argued that claims of being non-identifiable should be approached hesitantly. This is especially the case when the final account is to have a descriptive or a case study like that proposed by this study. Describing the context of each school and the selection procedures in detail makes it likely that people could be identifiable by others, even if names have been changed.

During negotiations with the schools, these issues were discussed with the principals and the teachers. One school did not have any objections to being identified. The possibility of the report being made public and the accompanying and possible identification of the school let another group of teachers feel vulnerable and exposed. This proves that it is sometimes dangerous to assert that no harm or embarrassment will come to those being researched. Punch (1998, p.176) warns that even people who have co-operated in research may feel hurt or embarrassed when the findings appear in print.

3.4 Research Process

Question 1: How do three senior phase teachers assess science in the General Education and Training Band?

Descriptive research (Schumacher & MacMillan, 1993, p.231) is concerned with the present, the current status of what is and since science-assessment competence is a contemporary phenomenon in a real-life context, with no clear boundaries between the phenomenon and the context, this study employs a
descriptive research approach. In order to succeed an in-depth case study with an ethnographic angle has been used. This angle in the research design allows the researcher to explore the science-assessment competence teachers have, over a period of time. Seeing that assessment and instruction are integrated, predetermined observations will take place in the learning programme to observe a complete learning unit per teacher.

My strategies of inquiry will be a case study that relies on interviewing, direct ethnographic observation and document analysis of tests and examinations set by the teachers. A case study involves multiple means of gathering data as an attempt to build an in-depth picture of the case (Cresswell, 1998, p.123). This justifies the complexity of the study, contributes to the triangulation of the data, and increases the level of rigour of the study. The ethnographic angle to the research will require observation of the teachers’ activities. Since the time spent in the classrooms does not allow the researcher to become an "insider" and also because of the elimination of possible influences of the researcher on the activities of teachers, non-participative observation was chosen instead of the traditional participative observation.

The interviews were supplemented by non-participative direct classroom observation and an analysis of the documents such as tests, projects and assessment records used during the learning unit observed. The evidence was then validated by in-depth, focussed interviews after the observation period. Triangulation of the identified competencies will add strength to the design, and will be established by the implementation of a combination of data collecting techniques and data sources. Classroom observations, document analysis as well as teacher interviews will be used to collect multiple forms of data.

**Question 2: What assessment competences are needed for effective science assessment?**

Documents of the national DoE, the Eastern Cape DoE as well as international literature on features of the new approach to assessment will be analysed. The
policy document of the national DoE regarding the implementation of an outcomes-based education system will be analysed to establish the science-assessment competence expected of the senior phase teachers to effectively assess science in the senior phase in South Africa. These expectations will be supplemented by those expressed in the in-service training material developed by the Eastern Cape DoE for the implementation of C2005 during 1998 and 1999.

**Question 3: What is the result of combining what exists with what is needed in South Africa?**

The evidence collected regarding the assessment practices of a collective case of science teachers will be compared with the data obtained from the analysis of the policy documents and international literature on good science assessment practices to facilitate the need for the development of an instrument aimed at determining the level of assessment competence displayed by classroom-based practices.

### 3.4.1 Setting up the research

There were three considerations in planning the research: ethics, multiple perspectives and multiple data collection methods.

**Ethics**

The ethical concerns concerning ongoing maintenance of confidentiality with respect to data and obtaining informed consent from all participants was my first consideration. These concerns were addressed at the beginning and during the project. I felt it would be necessary to address such concerns due to the relatively small area of Port Elizabeth in which the research was undertaken.

It was my policy to be open regarding the purpose and methods of the research with all participants. The principals of each school that participated were first contacted to request the participation of the schools, after which teachers involved were contacted and the purpose of the research was explained. The requirements of the study in terms of data collection were elaborated on.
The ethics governing the study were then outlined. These included the procedures I would follow setting up the interviews and the observations, ownership of the data analysis, obtaining informed consent from all participants, and maintaining the confidentiality and the accuracy of transcripts.

**Multiple perspectives**

The second consideration in the research design was that of multiple perspectives. Assessment involves examining actions in the classrooms as well as examining artefacts produced by the teachers and the learners during the assessment that are evidence of the assessment practices. Hence, two perspectives on classroom-based science assessment practices were obtained: those of the teachers’ actions in the classroom and those from the artefacts produced during the assessment process.

**Multiple data collection**

Multiple kinds of data and multiple ways of collecting data were used to increase the validity of the data collected and the data analysis. Data were generated through interviews, through non-interventionist observation and through document analysis. The teachers were interviewed using semi-structured interviews on aspects of classroom assessment.

Data from classrooms were collected via non-interventionist observation. I decided that in order to construct a rich, coherent and useful interpretation of assessment within a classroom, it was important to “see” the whole story of a teaching unit. This allowed me to become familiar with the context of the learning within the particular classroom for the particular unit. I would observe the teacher’s assessment practices as well as the learners’ interaction and meaning-making throughout the unit. Such continuity is important for naturalistic research where the researcher wishes to develop a valid interpretation of a complex process (Bell & Cowie, 1999, p.205). For this purpose, two Grade 7 teachers and one Grade 8 teacher were observed throughout their units of work in 2000 and 2001.
Data collection techniques used in support of the non-interventionist observation were fieldnotes, headnotes (mental records of observations which the researcher retained) (Bell & Cowie, 1999, p.205) and documentary data (the board, learner books, the walls, the teacher’s plan for the unit and the teacher’s record book). The multi-faceted data collection and the data analysis were managed within a framework provided by triangulation. Triangulation through the use of two or more methods of data collection is a technique used to increase the validity and reliability of the data collection and interpretation. In this research, different forms of triangulation (data triangulation and method triangulation) were achieved through a variety of methods. In order to ensure consistency during the collective cases, the data collection focused on establishing regularities of behaviour or competence (Bless & Higson-Smith, 1995, p.130).

3.4.1.1 Case selection
A sample of senior phase science teachers of the GET band in the Port Elizabeth region was chosen to represent the population of this research and this selection represents the boundary of the case study. The phenomenon of science assessment competence in the senior phase was studied as a collective case of 3 senior phase Science teachers, each teacher from a different school and covering a fair representation of both primary and secondary schools. This would strengthen the results by replicating the pattern matching, thus increasing confidence in the robustness of the theory (Tellis, 1997, p.4).

The senior phase of the GET band was chosen because a new curriculum has been implemented during the past five years. Traditionally Grade 7 is seen as part of the primary school sector in South Africa, while Grade 8 is part of the secondary school sector. With the implementation of a new curriculum, Grades 7 to 9 is considered to be one phase, namely the senior phase of the GET band of the NQF. The senior phase will also act as the first exit point of the GETC. The assessment practices of the teachers in this phase, consequently, will serve as a template for teachers in the lower grades who would focus on success in the GETC as the goal for their teaching. Being one phase has implications for the coherent assessment practices of the teachers and this necessitates the inclusion
of both primary and secondary teachers in the collective case to maximise the opportunity to learn from cases (Stake, 1995, p.4).

Teachers were also chosen to ensure the biggest variety and to ensure the collective cases represent "ordinary " (Plummer, in Cresswell, 1998, p.111) teachers. Two of the schools chosen (one primary and one secondary school) are so-called White schools where the majority of the learners in the schools are White while one primary school was a Black school. The teachers that were chosen provide an example of a large population of science teachers in the Eastern Cape province. In addition to grade level, diversity was sought in terms of the nature of the community, anticipated levels of competence in science assessment and location in Port Elizabeth. Geographic proximity was taken into consideration when selecting all the schools within the Port Elizabeth area. I looked for schools that would be accessible; willing to participate in the study and that would provide the required diversity.

I selected three schools: one primary school in a middle-income predominantly white community, one primary school in a low-income black community, and one white secondary school. The one primary school only has learners in Grades 5, 6 and 7. This provided the bounded system of senior phase science teachers needed in the case study. It is unlikely that all schools in South Africa will be represented in this case selection. However, I am confident that I would find common science assessment practices and that I could learn enough about their science assessment competence to be able to develop an instrument that can be used for self-assessment by teachers.

The collective cases were not chosen primarily for representation, because representation by a small sample is difficult to defend. The focus was more on the schools’ usefulness in terms of contribution to the deeper understanding of the science assessment practice of the sample of South African science teachers. As Stake (1995, p.6) argues: “balance and variety are important and opportunity to learn is of primary importance”.

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School 2’s teacher, Grace, was exposed to above-average training for the new developments in assessment since she had attended the departmental in-service training for C2005 implementation in Grade 7 as well as Grade 8 the following year. One of the regional facilitators for in-service training for the implementation of the Mathematics learning area is her colleague. Michael and Annette, the teachers at School 1 and 3 were chosen because their schools are representative of ordinary, suburban schools with access to a variety of resources. They both only underwent the expected one-week training given to all their fellow Grade 7 or Grade 8 colleagues. They thus represent the ordinary teacher at an ordinary school.

The case study consists of two variations and types of institutions, namely, the primary schools and the secondary schools. For the collective multiple case study (Cresswell, 1998, pp. 114, 119) typical cases consisting of ordinary teachers in ordinary schools were selected. They where chosen to highlight what is the “normal” and the average science assessment practice in the senior phase in the Eastern Cape schools. They were chosen to include politically important cases (Cresswell, 1998, p.119). This provided the rich description of typical schools in the Eastern Cape.

3.4.2 Multiple data collection strategies
Since qualitative research is multi-method in focus, as central empirical material it has collection techniques, observation, interviewing and document analysis (Punch, 1998, p.158). In order for a case study to provide an in-depth picture of the case or collection of cases, it should involve multiple means of generating data (Cresswell, 1998, p.123), as is the case in this study. This focus on employing a variety of methods to collect data will do justice to the complexity of this study, will contribute to the trustworthiness of the data, namely triangulation, and will increase the rigour of this study. Each of these data collection strategies employed in the study will now be discussed in detail.
3.4.2.1 Interviews
My relativist ontological position, namely multiple socially constructed realities that are complex and ever changing, suggests that the science teachers’ knowledge, their interpretations of the C2005 policy and training documents are meaningful properties of the social reality of science assessment competence, which my research question will probe. The description of the science assessment practices places emphasis on the need for depth, complexity and roundedness in the data. This was achieved by employing "qualitative interviews" (Mason, 1996, p.38) with the teachers. The interviews provided issues that guided the classroom observations.

The interview schedule was flexible with a few basic themes that allowed me to probe into the respondent’s responses (Hitchcock & Hughes, 1989, p.157). Non-structured interviews presuppose some prior information and an understanding of the problem under investigation (Bless & Higson-Smith, 1995, p.107). My background as a science teacher educator combined with the preliminary literature survey provided me with the prior understanding needed for the interviews.

3.4.2.2 Non-participant observation
Qualitative observation is fundamentally naturalistic in essence. It occurs in the natural context of occurrence, among participants who would naturally be participating in interaction. Pepper (in Hopkins, 1993, p.151) says “observations are always interpretations of the facts observed” and that the interpretations take place in the light of theories. Hopkins points out that the word ‘theory’ also implies personal theory – the assumptions and beliefs that guide your actions (1993, p.151).

The teachers’ science-assessment practices were analysed by observing the teachers in classrooms. The purpose of the observations is to record what is happening for future analysis, and not to make any kind of value judgement. General aspects of methodology, integration of assessment and learning, amount of teacher talk and student talk as well as the nature of student activities formed the framework for the classroom observations.
The role of the Researcher in the Observation

I started with a preliminary mind-set as teacher educator and what would be expected in terms of science assessment actions. I tried to remain unblemished by preconceptions and to record everything that occurred. After the first school’s observation session, I hunted through the collected records to locate patterns to be used as themes for the report. I realised it was unrealistic to approach a task with a completely open mind.

I took freehand notes during the lessons observed and noted “critical events” (Wragg, 1994, p.63). The fieldnotes were then typed and the information grouped under headings to start the process of analysis. In the cases where the same lesson was repeated for other classes, the first class’s observation notes were supplemented with the follow-up classroom’s field notes. My notes or “lesson protocol” was thus typed (Wragg, 1994, p.73) for the analysis.

The focus of the classroom observation was on the science assessment practices of the teacher. Assessment and instruction is so integrated that assessment practices cannot be observed in isolation. One’s instruction influences both formative and summative assessment in the classroom. This explains the necessity for the ethnographic angle chosen for the research methodology. The classroom atmosphere; the learners’ perception; the feedback provided and the measurability of the objective of the teacher all influence the formative assessment in the classroom.

My field notes were typed soon after the observation period. They reflected the general impressions of the classroom, its climate and the incidental events related to the assessment of science in the classroom. They are descriptive enough to build up a broad picture for data analysis.

Establishment of trust during observation

Hopkins (1993, p.77) warns against moving too quickly when observing a teacher’s classroom practice. The most important issue when observing a teacher is the establishment of a climate of trust, with the teacher as well as with the learners.
In my relationship with the learners, at first I allowed myself to be approached by learners’ for correct answers when they got stuck. Younger learners have a natural tendency to want to talk to anyone that visits them and show off their work. They started treating me as a teacher-surrogate. Fearing that I would change the role of non-participant observer, I had to withdraw and stay as un-noticeable as possible in all the classes. During the observation period, I was positioned at the back of the class and within vision of most of the learners. That way they could see what I was doing and ignore me after a while. The very presence of an additional adult who is not normally present may itself influence what happens in the classroom (Wragg, 1994, p.14). I tried to minimise the intrusion, made contact with the teacher beforehand, clarified the purpose and the likely outcome of the observation to make it as natural and unstaged as possible.

In order to establish a climate of trust in a potentially threatening or judgemental situation, the freehand field notes of the first period observed were handed to the teacher to read. The aim was to acquaint her with my style of taking notes during the observation and to assure her of my role as an interested, non-judgmental observer.

The purpose of the observation was made clear: to record what is happening for future analysis, and not to make any kind of value judgement. The danger of my observation was that the teachers were subjected to a series of “mini-judgements” (Hopkins, 1993, p.78) on their teaching. I tried to establish a non-judgmental atmosphere by deciding on a very broad observation schedule before the observation period. The observation method was an open observation approach where I used a blank sheet of paper to record the lesson. In order to avoid reaching premature judgements I made the open recording as factual as possible and left the interpretation for later.

Recording of the observation

I decided against the use of videotape recording during the first week of school 2’s observation period to nurture the trust established. However, when introduced in
the second week, the novelty of technology caused the learners to react differently. This upset the teacher’s flow in the one period and I immediately decided against the recording of the lessons.

**The classroom observation schedule**

The major focus of the study was to identify and to describe science assessment practices in and across the range of teachers and schools. I observed three teachers from whom the classroom and the interview data were gathered.

The schedule contained qualitative elements and had two main components:

- Biographical and infrastructure information for each class observed (these were filled in during the lessons); and
- A narration of each lesson by the observer that described the steps of each lesson as it unfolded (these were also filled in during the lesson).

The observation schedule described elements of assessment practice so that the observer could mark a position that captured a teacher’s practice in relation to this element observed in each school. In that way, trends and divergences within a teacher (or across the lessons) and trends and divergences across all the teachers could be distinguished.

A concern throughout the development of the schedule was that by pre-structuring practice into discrete elements for observation and noting, aspects of assessment could be obscured, so that other relational and complex ways in which elements of teaching interact are in effect, washed out. The narration of the lesson unit progress and a videotext for some of the teachers were the means adopted to avoid such distortions.

3.4.2.3 Documentary evidence

This comprised test papers, examination papers, class workbooks from the schools and support material available to the teacher. I made use of class workbooks and test books in which the learners keep record of their learning and their assessments. I occasionally asked learners to verify some facts such as criteria
given before or with the assessment task, correction to tests and instructions given with the projects.

### 3.4.3 Problems experienced during data collection

Disruptions to carefully conceived plans tend to be the norm rather than the exception to any educational research in South Africa (Vithal, 1998, p.475). The disruptions experienced in this research design produced disruptions in the data, although it was still possible to complete the research.

During the data collection phase of the research, I encountered an accumulation of unanticipated difficulties. This ranged from varying interpretations of the request to observe a single teacher at a school where more than one teacher is teaching the same subject for the same grades – to restrictions to access during the attempt to observe at some schools. Firstly, not all the schools that I contacted agreed to partake in the research. What was evident was the trend that the non-European schools were more reluctant to allow a researcher in their schools. This was in line with the conclusion Vithal (1998, p.476) came to in her study of Mathematics education at “difficult” schools. A possible explanation for this reaction from former disadvantaged schools could be found in the history of school-based research during the apartheid era where research was “done on people” especially Black people (Vithal, 1998, p.279).

The outcome of the selection of schools was that my cases consisted of two “white” schools (schools with dominantly white learners and staff members), which were very co-operative, and one “black” school (with only black learners and predominantly black staff members) initially, who were not enthusiastic. Although careful and extensive negotiations took place for my access to School 2, I arrived twice at the school only to find that neither the principal nor the science teacher were present. Eventually I could only interview the teacher in one term and had to wait until the next year to arrange the observation period with the teacher. In the period between the interview and the observation sequence, I acted as a C2005 in-service training facilitator in the Natural Science Learning Area for the Eastern Cape Department of Education. The teacher of school 2 was one of the
participants. This resulted in smooth access to the observation process that happened a few weeks after the in-service training. On the other hand, Grace (the teacher of school 2) wanted feedback on where she could improve. This caused a dilemma for my status as non-participant non-judgemental observer. I could not help without losing the ability to describe what happens in a “normal” South African classroom. I had to politely answer her as vaguely as possible and emphasise the purpose of the observation period during every short break that we had between the lessons observed. I also showed her the field notes to reassure her of the non-judgemental descriptive nature of it in an attempt to maintain the relationship of an interested, but non-interventionist observer.

### 3.4.4 Summary

This chapter discussed the planning of the research. This lead to the answering of sub question 1 by describing how three senior phase teachers assess science in the GET band, by analysing the interviews, the observation data records as well as the documents produces during assessment practices.
Chapter Four
Data Collection

4.1 CONTEXTS OF THE STUDY

I chose the case study methodology because it allows me to understand complex situations with many intertwined variables. In the following sections, I describe the data collection and the analysis of the assessment practices observed in three science classrooms in the Port Elizabeth region. The description will blend biographical information with the assessment practices of the participant teachers to describe the complex situation at each individual school. I visited the three teachers for two consecutive weeks each, observed their teaching and consequently their assessment practices, interviewed them formally and informally, and collected data from the artefacts produced by the learners and the teachers, regarding assessment. Collectively the stories developed from each school helped me to generate the findings I present in this chapter. The intense period of classroom observations allowed me to compare the findings of the different schools.

Firstly, biographical information of each participant teacher and the individual school are blended to create a profile for each teacher. Thereafter the assessment practices of each teacher are discussed under the following headings:

1. Planning;
2. Formative assessment;
3. Summative assessment; and
4. Groupwork.

Although more aspects could be interrogated, this study only focuses on the aspects mentioned above as the most prominent areas identified in Chapter 2.

Three teachers from different urban schools (the names below are pseudonyms) participated in this study: Michael from School 1, Grace from School 2 and Annette from School 3. The school observation will focus on all three teachers. The three teachers had between 8 to 22 years of teaching experience. Michael had been...
teaching science in two Grade 7 classes with about 35 learners in each class. Grace taught science in Grade 7 in seven different classes, with an average of 35 learners. She had twenty years of teaching experience. During her career, she taught Science, English and Mathematics. Both Michael and Grace had been trained as primary school teachers. Annette taught science in Grade 8 (30 learners) and Grade 9 (36 learners). She had been trained as a secondary school Physical Science teacher. Annette had twenty-two years of teaching experience, a few years of which had been spent at a teacher-training college.

The three teachers had been exposed to a period of one-week training provided by the national DoE at the introduction of Curriculum 2005 (C2005). Grace attended two training sessions for C2005, one for Grade 7 and one for Grade 8 the following year. These were one-week training sessions done by the Eastern Cape DoE. She had thus more training than a “normal” Grade 7 teacher.

The schools are situated within a radius of between 25 km and 35 km from each other and in close proximity to Port Elizabeth, with access to museums, parks, an oceanarium, a snake park and the ocean. The schools are similar in respect of some general features. They each have a library, although varied in terms of the size and the availability of material. They have access to textbooks for learners as well as extra textbooks that serve as resources for the teachers. The amount of audio-visual equipment varied from one overhead projector at school 2 to access to a television monitor and computers in schools 1 and 3. Laboratory equipment for practical work exists in all the schools, although there is no separate laboratory in each school and the availability of the equipment varies. Since the presence of a permanent laboratory is not as important for effective science teaching (Bentley & Watts, 1992, p.32) as access to equipment and running water, it may be said all the schools were adequately equipped.

The learners in the schools have diverse racial and socio-economic backgrounds, including both low-income and middle-income groups. This provides a suitable spread of the economic status of the Port Elizabeth population. The middle-income groups form a higher percentage in Michael’s class, while Grace’s class has very
poor learners with most parents staying in informal settlements. Funding and a lack of resources constrain education in this school. Teaching at Grace’s school is constrained by the lack of necessary consumables such as stationery rather than by the lack of equipment. The school had received generous donations of science equipment in the past, but learners do not have pencils and paper. Although the community in Michael’s school pays their school levies, acquiring science equipment was not regarded a priority. Annette’s school has a fair collection of apparatus and of equipment. The school community places a high priority on the appointment of additional teachers for the school so funds are also limited, but with careful budgeting and prioritising, she has a functional laboratory. In terms of having adequate equipment for practical work Annette’s school is the best resourced, with Grace’s next and Michael’s last.

Another similarity between the three schools is that all the teachers who participated in the study had the support of their school’s principal and management staff for innovations they wanted to implement. There seemed to be a good working relationship between the staff members of the individual schools. The management of the schools could also provide each of the schools with a safe teaching and learning environment. Each school has a fence and a gate that is locked in the morning and only opened on request during the school day. This provides a safe environment for the teachers and the learners and represents essential aspects for a culture of learning.

Even though there were common characteristics between the schools that participated in the research, each school and each teacher had a unique and complex situation in which they functioned. In the forthcoming section, I will provide biographical information of the three teachers as well as contextual information about the three schools in which there was classroom observation.

4.2 Profiles of the Learning Environment

4.2.1 School 1

School 1 is a dual medium school located in a middle-class suburb. Michael is a male English speaking teacher who teaches science to the English-medium Grade
7 learners. He is not the only science teacher at the school. He has a colleague who teaches the Afrikaans-medium classes. The colleague has about twenty years teaching experience and acts as mentor to Michael, who started his teaching career at School 1 with his colleague as the senior teacher at the school.

Teachers are allocated permanent classrooms so learners have to move to the teachers. The teachers are not closely involved with discipline in the corridors during the rotation of learners between periods. The rotation of the learners is noisy and learners tend to arrive at the classroom in groups. No-one monitors the movement of the learners between periods.

The classroom allocated to Michael had a built in washbasin and was big enough for the arrangement of loose tables and chairs. The teacher’s table was located at the back of the classroom with cupboards both at the back and at the front.

Michael is a qualified senior primary teacher. He received his four-year National Diploma in Education: Senior Primary, from a College of Education with Education and History as major subjects and Biology as a third year subject. Michael attended the one-week standard training course offered by the Department of Education (DoE) for the implementation of C2005. There were opportunities for extra workshops after the initial training, but Michael did not attend any of those. His comment was that he had “too much to do in terms of extra mural activities”. He preferred to get feedback from other teachers who attended such workshops. Even though this cascading model of information dissemination was not found to be successful for the implementation of Curriculum 2005 (DoE, 2000a), he still preferred it.

The learners do not use a particular textbook. He has textbooks that are no longer prescribed; they are in the storeroom, for use by the learners when needed. The learners are provided with photocopied notes or worksheets, which they staple together with any other artefacts they produce during a learning unit. This set of stapled papers will be given a front page by the learners and then called a
“chapter”. An example of such a “chapter” would be: “Mass and Measurement” or “Classification of the Animal Kingdom”.

The school has a laboratory with benches, gas lines, a fume cupboard and running water, but the laboratory is not used regularly. Michael only took his Grade 7 learners to the laboratory once during the year that I observed his teaching, and that was for the first unit of the year, the “Mass and Measurement” unit. He believed that the learners would break the apparatus, in particular the glassware, and “there is no money to replace it”. During an interview, he was asked to comment on the budget process and the availability of funds in his school.

M: We budget for that [equipment for the laboratory]. If there is money, then we buy the equipment. And each grade has a separate smaller budget…Basically about four, five hundred rand for each grade for the year for ‘in case’. If you get a smart book, it comes out of this fund.
E: Would you say that you have enough money?
M: Yes

Michael did not make use of the laboratory at all during the observation period. The laboratory is generally locked, and equipment is also locked in cupboards. The equipment was not used regularly and was not in very good working order. Michael’s focus and strength was more on the Biology than on the Physics and Chemistry themes of the curriculum. The equipment needed to effectively teach the Physics and Chemistry was not a priority for Michael. He was satisfied with the condition and the use of the laboratory as it was during the observation period. He used his money to take the learners on field-trips to nearby environmental sites, a shopping centre or to buy a good book.

According to Michael a variety of teaching techniques were used throughout the Grade 7 year. He made ample use of groupwork (about 80% of the activities were centred on groupwork) and he supplemented it with their completion of worksheets, a project, the lecture method and a computer-based information search activity. Michael explained that a typical learning unit would start with an introduction that would have, as aim, the practical discovery of the module. For the disclosure of the content videos, pictures, charts and their textbooks would be used. Then he would
summarise and conclude the modules by highlighting or emphasising important facts (reading them from a copied information sheet or worksheet). It is expected of the learners to highlight important aspects on those copied worksheets.

Different learning units were taught with different teaching approaches and techniques. According to Michael, the learning unit on Magnetism was taught “formally”. This means no groupwork was done and the telling method was used. The reason for this was that Magnetism is “abstract information that needs to be taught. It cannot be discovered by the learners”. The learning unit on Energy was done in a similar fashion.

The learning environment that Michael created engaged learners in activities that were not always well structured. Given that the purpose of the activities was not always clearly spelled out in the instructions to learners, the end result of the activities did not always produce the type of evidence that he had planned for, as illustrated by the following situation. Michael indicated on a written plan that, for the introduction to the learning unit on Plants, he would like learners to collect a variety of leaves and flowers from the school grounds, make leaf prints or draw the flowers on a sheet of white paper.

The following is a typed transcript of the planning for the learning unit observed.

1. **Introduction: Practical**
   Collect leaves/plant flowers
   Shade leaves → chapter. Reason: it is a fun activity and they "learn" without knowing i.e. veins of leaves.

In the learning unit or “chapter” on Plants the content he planned to cover was a description of Monocotyledons and Dicotyledons regarding their roots, stems, leaves and flowers. He planned to use the leaf prints as the front page for the “chapter”, illustrating the different shapes of the leaves and the veins. When he eventually gave the learners the instruction for this activity, he tried to give instructions without taking the fun element away, but in the end the activity resulted in learners focusing on the drawing instead of engaging them with the characteristics of the two leaf types as he had planned to do.
M: Listen carefully. I am going to give you say 10 minutes and this is what you must do. This area here outside the classroom, on the perimeter of the school – I am going to give you 8 – 10 minutes to collect 2 – 3 leaves each and then say a flower or two. Collect any leaves, but do not jump over the neighbours’ fences. I repeat – only stay on the school grounds. Obviously, you do not need to pick the highest branches, choose the easy to reach leaves. Two to three leaves each per group and say each one a flower. You do not need more than three flowers per group. So basically in 8 minutes time you must be back for your first activity on the growth and reproduction of plants.

None of the instructions had a clear task to perform by the learners. First, they are given 10 minutes to complete the task, then 8 minutes. Although he mentions the topic as being an introduction to the growth and reproduction of plants, during the next four periods he did not refer to the topic again. The leaves learners collected were mostly that of Dicotyledons while the flowers were one of about two varieties, not the variety you would hope to have when starting to recognise vein patterns in Monocotyledons and Dicotyledons. After the learners came back the following set of instructions were given.

M: The white page I am handing out to you now, you must do the following with. On the page – there is the heading “plants”. [The teacher pointed towards the green board on which the heading Plants appears in a block, centred at the top.] Then you are going to take for example your leaves or whatever. Put it behind the page, use Grade 1 or Grade 2 art, and scratch over the leave with your pencil or crayons. You can either use the back or the front of your leaves. You can even use your flower, but it will be more difficult, but I want mostly leaves on here so that the leaf patterns come through. And then for example, if it does not come out so clearly, you can make a rough sketch of it. There are some people who sketch nice in the class, so you can make a sketch of your flower. If you do not have enough leaves, you can use from the group next to you. You have got 10 minutes – 10 to 12 minutes to get that done with pencil or crayons. Any questions? (No questions from the learners). Any questions? (Again none.)

Once again he instructed the learners to collect flowers, but left the impression that it was optional to use the flowers collected. With the instructions to make a leaf print, he does not alert them to observe the patterns and suggest differences and similarities. There is also a contradiction in terms of the type of sketches he wants for the flowers. He first said that a rough sketch can be made, whereafter he suggested that a sketch be drawn. Nowhere did the instructions include sketches
of the particular flowers or leaves collected - they could interpret it as 'any sketch of any flower would do'. The planned aim for this activity did not materialise.

In the midst of this noisy atmosphere, the teacher then attempted to add the following comment without drawing all the learners’ attention to him. Some learners paid attention, while others looked at their friends in the groups who started to make prints, and the rest of the class were busy with other things. The instruction given was as a result of a question asked by one of the learners. It can be deduced that Michael did not consider the question to be important enough to include in his original instructions - it was more a case of an afterthought.

M: The page I just gave out is the one that goes in your chapter. You do this neatly. It is going to form part of your chapter.

No follow-up happened after the activity was completed. They moved on to the following activity planned, which was the brainstorming of plant words. This created a learning environment that consisted of fragmented bits of unrelated activities, with very little chance for making a connection between the activities and the building of conceptual knowledge and understanding.

One of Michael’s strengths was the emphasis on the development of a value system and accompanying attitudes. In a reflection regarding the merits of his new assessment practices, he commented:

M: I think that you have a more holistic and total picture of the learners than in the past. Especially with all those attitudes and values, that receives attention. You actually have more insight now in the learner than you had in the past.

In conclusion, Michael teaches at a school where funding and financial resources do not constrain his teaching or assessment practices.

4.2.2 School 2

The school where Grace teaches is located in a Black township in Port Elizabeth. Grace is Xhosa-speaking, and she teaches science to all the Grade 7 classes where learners are also Xhosa-speaking. The medium of instruction in School 2 is
English. As mentioned earlier, the school is situated in a poor socio-economic
community where parents do not have money for their children’s education.

The school only accommodates learners in Grades 5, 6 and 7. The layout of the
school is such that the Grade 7 teachers often do not see the Grade 6 and Grade 5
teachers, since every grade has its own level in the building complex. The Grade
7s occupy the ground floor classrooms, while other Grades use other floors of the
school complex. Grace was allocated a classroom in which she stays for all her
science lessons. The classroom is big enough to arrange chairs and tables in
groups, with no more than six learners per group. The teacher’s table is at the back
of the classroom with the board and the door at the front of the classroom.

The teachers have a resident classroom, while the learners move from one class to
another. The teachers are actively involved in the discipline of the learners and
manage the movement of learners from one class to another. No loitering is
allowed on the verandas between the periods since the teachers wait for their
learners outside the classroom at the start of each period.

Each learner was in possession of a textbook approved and purchased by the
Department of Education. These textbooks were written in the Curriculum 2005
format. There are two different sets of thirty “old” textbooks available on a table at
the back of the classroom, for learners’ use. Grace had five other textbooks (some
written in the new curriculum style, some international books and 1 additional
textbook written for the phased out curriculum) at her disposal for planning
purposes and use as general resource. The new textbooks discussed the specific
and critical outcomes for Natural Sciences in the senior phase and illustrate their
use in the planning and presentation of the content in the textbook. Even though
Grace had 5 reference books at her disposal she could not make photocopies for
her learners because of a lack of funds.

The school does not have a laboratory, but has a storeroom with enough
equipment and apparatus to do a substantial number of practical investigations
with the learners, provided they work in groups. There is sufficient equipment to
cover all the traditional topics in Grade 7. Although there are enough chemicals available, consumables such as spirits and matches for the burners were in short supply. Most of the equipment she had was as a result of donations from outside sponsors, but were a once-off donation and sustained use of the equipment was threatened by this lack of funding. There were chemicals in the storeroom, but the problem was that the school needed to purchase spirits, which they could not afford. Grace had to pay for that out of her own pocket if she wanted to use it, which she had done once during the observation period.

Grace’s classroom also doubles as a laboratory when she wants to do practical work. Running water is available outside her classroom. The storeroom for her equipment is located in the administration building, approximately 100 m away from her classroom. She had to fetch the equipment at the beginning of the day and then lock it up at the end. No equipment or valuable items could be left in the classroom overnight because of a possible theft. This posed a hindrance to the incorporation of practical work into the curriculum of School 2.

Grace is a qualified Senior Primary teacher with a National Diploma in Education: Senior Primary, with English as a major subject as well as a Further Diploma in Education: Technology with Science for Technology, as one of the subjects. She has twenty years of teaching experience as a Grade 7 teacher of Science, Mathematics and English.

Grace has had a problem with scaling down the curriculum from the traditional topics she was used to teaching. In the year the observation took place, she covered three units (Matter and Measurement, Vertebrates, Energy and Energy Transfer) during the first six months of the year. During an informal interview, she indicated that she still had to do six more topics in the last six months of the year, which is double the amount of work she had covered during the first six months. She explained that she felt obliged to cover at least the Chemistry and Physics topics since the Grace 8 teachers in the high schools would have to build on those topics (Acids and Bases; Forces; Magnetism).
In conclusion a comment from one of Grace’s colleagues summarises the ethos at the school:

“We are struggling with assessment. But we are trying our best.”

Thus, there is a positive willingness, with a hint of negativity, to engage with changes expected of them especially in terms of assessment.

4.2.3 School 3

School 3 is an Afrikaans-medium school located in an urban middle class suburb. Annette teaches science for the Grade 8 and Grade 9 classes as well as Physical Science for Grade 10 to Grade 12. The staff of school 3 consists of 19 Department of Education appointments and 9 “school governing body” appointments. The school enrolls learners from a middle socio-economic background and most of the parents pay their school levies. Although this is the case, the high number of extra posts created by the school governing body limits the availability of funds at the school. The relationship between the staff members is good and there is a strong network structure in place.

Annette only teaches the Physical Science component of the Grade 8 and Grade 9 Natural Science learning area. A qualified Biology teacher teaches the Biology component of the learning area since the school is of the opinion that a teacher needs to have strong content knowledge in order to provide the learners with optimum learning experiences in the new Curriculum 2005. Since the case study employed an ethnographic angle to the data collection, I decided to focus the intense period of classroom observations only on Annette.

Annette qualified as a secondary school science teacher by obtaining a BSc with Mathematics and Physics as her major subjects and Chemistry at second level. In addition, she obtained a BSc Honours, a Higher Diploma in Education as well as a BEd (Hons) degree. She also has 5 years of experience at a teacher training college.
Annette was allocated two rooms for the teaching of science and Physical science. One of them is a lecture room built in an auditorium style. The desks are stepped in rows, and higher towards the back of the class to facilitate a view of the demonstration bench from the back. The blackboard is behind the demonstration bench. The arrangement of the classroom is not conducive to groupwork. This is only possible in the laboratory next door.

The laboratory has fixed workbenches with working surfaces against the sides and the back of the class. The laboratory has functional gas, running water, a fume cupboard as well as cupboards that could be locked. They also have the services of a laboratory assistant cum library assistant. The laboratory assistant has a National Higher Diploma in Education, specialising in Biology. Although she does not have any Physical Science training, she assists Annette in setting up and cleaning up after the practical work.

Having painted a picture of each teacher’s environment, it is necessary to focus on the classrooms. Here the assessment practices of the three teachers may be determined in relation to their planning, the types of assessment and the use of groupwork. Sorensen (2000, p.127) emphasises that assessment should be contained in teachers’ “schemes of work” and be an integral part of lesson planning. It is common practice that careful and detailed planning is needed for the effective teaching and effective assessment of learners’ knowledge and understanding, that should lead to the application of their understanding in a variety of contexts. It is also expected of the teacher to individualise the activities for his or her own unique classroom context. The first of the classroom-based assessment practices that will receive attention will be the planning by the teachers for learning and assessment activities.

4.3 Planning for Learning and Assessment Activities

4.3.1 Michael

Although Michael knows what he wants to do in his class, he does not plan in detail. He has a mental draft of what he plans to do, but there is no detailed plan to ensure that the full domain of science learning in grade 7 is addressed.
integration of the learning outcomes, the design of appropriate learning experiences, and the teaching strategies to be used, activities, and the most appropriate assessment strategy to gather the evidence of the learning is in danger of not taking place. The school does not have a policy or an overall goal for the teaching of Natural Sciences in Grade 7. The designing of the learning programme is left to the two science teachers' professional judgement. Planning is not a priority with Michael. His comment during the follow-up interview early in the year after the observation took place:

M:  The planning…yes, I probably never before planned so much like I am doing now.

The lack of focus on detail in his planning is evident from the hand written plan that Michael provided at the beginning of the learning unit on Plants. The intense observation period happened during this learning unit. The following is a typed transcript of the planning Michael presented for the learning unit observed.

1  Introduction: Practical
   •  Collect leaves/plant flowers
   •  Shade leaves → Chapter. Reason: it is a fun activity and they "learn" without knowing i.e. veins of leaves.
   •  Brainstorm plant words
   •  Make poster with words from brainstorm (4 in 1) to be displayed in the class for the duration of the unit.
   •  Ask the groups what they have learnt.
   •  Groupwork + task + presentation + assessment (see further on).

2.  Practical (Sketches) - page for Chapters.

<table>
<thead>
<tr>
<th>ALGAE</th>
<th>FUNGI</th>
</tr>
</thead>
<tbody>
<tr>
<td>pp. 238/239/240</td>
<td>p. 245</td>
</tr>
<tr>
<td>FERNS</td>
<td>CONES</td>
</tr>
<tr>
<td>p. 249</td>
<td>pp. 256/260</td>
</tr>
<tr>
<td>DICOTYLEDONS</td>
<td>MONOCOTYLEDONS</td>
</tr>
<tr>
<td>pp. 265/269</td>
<td>pp. 273/275</td>
</tr>
</tbody>
</table>
Textbook used:
[It is one of the old textbooks from the storeroom that was available for this task.]

The above shows the different plant-groups we can find. Use the above pages for ideas. Sketches from the various groups from textbook. Learners discover what different groups look like and label - Discover own words and identify with sketch.
[Although the learners did not have textbooks, Michael provided them with the old textbooks that he keeps in the storeroom.]

3. Group presentations
Each group received a different book about plants. Discuss their presentation in groups (1,5 hours of planning in class). Make a poster/teaching aids. Present talks.
Skills:
• Looking through book, find relevant information and process.
• Plan - ideas onto paper.
• Group leader/peacekeeper.
• Presentation skills and time management.
Assessment:
Self-; group-; class-; and educator assessment.
Discuss and identify "problem" areas, solutions, where to improve.

4. Worksheets
Formal teaching. Explain/highlight important sections and labels.
Media:
transparencies/posters [made by learners]/pictures.

5. Fruit salad/salad
Fun activity - groups.
Aim: what minerals/vitamins are stored in plants and how are they beneficial to us (health).

6. Herbs/ Herbalists
Discussion
(informal - learners find out - report back).

7. Assessment:
Class test to test whether the pupils/learners have grasped the new terms/practical.

He had a broad plan of action, but there was little detail. Another case where the planning did not correlate with the assessment practices was with the group’s oral presentations. Michael planned to assess the learners’ skills in terms of:
1. Collection of relevant information;
2. Planning the presentation;
3. Working in groups;
4. Time management; and
5. Doing a presentation.

When the presentations were done, the above criteria were not used. Michael discussed the assessment criteria for the oral presentations just before the groups did their presentations. Aspects such as planning and time management were not assessed. Only the presentation skills he had planned to use earlier were used as criteria for the assessment of presentations. Instructions were given to the learners to prepare an oral presentation, but no mention was made of the criteria for the assessment of the oral presentations. Broad aspects of doing a presentation were mentioned in the classroom, but the weighting and the level of achievement expected from the learners in each of these broad aspects were not mentioned. The assessments (group-, class- and educator assessment) were completed without most of the learners knowing what the expected level of performance had to be. The marks earned for the presentation was one of the summative assessment marks recorded for this learning unit. No opportunity to improve or to re-do the presentation was provided.

4.3.2 Grace
A similar situation in terms of “planning that does not match the practice” exists with Grace. Evidence from the artefacts analysed and the classroom practice does not match the planning as set out on the planning sheet in Grace’s preparation file. The observation took place during the year that Grace went for her second training session on the implementation of C2005. In her teacher-file, she had a planning document that was based on the format suggested by the DoE during their training. The planning in Grace’s preparation file was a table with the Phase Organiser and the Programme Organiser (as required by the DoE) as headings. The table on the next page represents the planning in Grace’s preparation file.
Although the new terminology had been used in the planning, the planning lacks detail and clarity on exactly what will happen in the classroom. During an informal interview, Grace indicated that she had covered the following topics during the first semester of that year:

1. Matter and Measurement;
2. Vertebrates; and
3. Energy and Energy Transfer [The unit that I observed at the end of the second term].

The unit on “Vertebrates” was scheduled for the fourth term, while the unit on “Energy and Energy Transfer” was due in the third term. She planned to still cover the following “learning units” during the rest of the year:

1. Acids and Bases;
2. Forces;
3. Magnets;
4. Invertebrates (only one example of an invertebrate);
5. Flowering plants – pine, fern and breadmould [the examples given are non-flowering plants]; and

The topics “Acids and Bases”, “Forces” and “Magnets” are linked to the theme of “Matter and Material” she planned to do in the first term. It is clear that Grace did
not implement the planning as set out in the beginning of the year. These topics feature in the previous syllabus before C2005 introduced the four themes for the learning area. Therefore these were topics with which she was familiar. Her indication of the topics does not seem to address the theme “Earth and Beyond” which, according to her file, was supposed to have been done during my observation.

The reason Grace provided for cramming such large amounts of work for the year was that she felt obliged to cover at least the Chemistry and Physics topics during the rest of the year since the Grade 8 teachers in the high schools would build on those topics. Although she attended the training for Grade 8 teachers, she still held the belief that the Grade 8 teachers had a syllabus to cover and expected her to provide learners with a certain body of knowledge. She felt that it was expected of her as a Grade 7 teacher to ensure that her learners received an introduction to Acids and Bases, Forces and Magnets.

The following medium term planning was done for the term 1. It was another set of planning sheets filed in the preparation file. No evidence was found of medium term planning for the rest of the year.

**Unit 1:** Matter and Material: Measurement.

Knowledge: Properties of matter.

Skills: Decision-making. Asking questions, Problem solving.

Learning Experiences: Collecting of material for measuring. Ruler, Measuring tape, callipers.

Assessment: Informal teacher assessment of plan and construction of measuring instrument.

Resources: Textbooks, callipers, ruler.

**Unit 2:** Matter: Measurement.

Knowledge: Importance of accurate measurement.

Skills: Decision-making. Learners formulate investigative questions.

Learning Experiences: Using a meter stick; ruler; callipers; measuring tape. They measure their waists, etc.

Assessment: Group work, class work, written test.

Resources: Textbooks, Metre stick, callipers, measuring tape.
Unit 3: Measurement: Area

Knowledge: What is an area? Demonstrate an understanding of concepts and principles and constructed knowledge in Natural Sciences.


Learning Experiences: Measuring, comparing, drawing of rectangles and squares.

Assessment: Working out the area of a square and of a rectangle.

Resources: Textbook; Metre stick, Ruler.

Unit 4: Matter: Area of a circle

Knowledge: Use process skills to investigate phenomena related to the Natural Sciences.

Skills: Using callipers they must be able to measure circles.

Learning experiences: Making of a circle. Identifying circumferences, diameter and radius.

Assessment: Learners conduct explorative investigation.

Resources: Textbook callipers.

No further written planning was done for the rest of the year.

Grace wrote the following work scheme for the unit that I observed before I arrived.

The format is identical to the format provided by the national DoE to the teachers during their C2005 training. The cryptic inscriptions are taken directly from the planning document provided by Grace.

Table 4.2 Grace: Work scheme for “Energy and Energy Transfer” unit

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Skills</th>
<th>Learning experiences</th>
<th>Assessment</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is energy.</td>
<td>Job that the light do for us. Learners are able to switch the light on.</td>
<td>Reaching consensus on what we mean by the word energy in science.</td>
<td>Observation</td>
<td>Books</td>
</tr>
<tr>
<td>Learners be able to identify sources of energy in various situations.</td>
<td>Pupils from the disadvantaged area be able to use other sources of heat without using</td>
<td>Interaction among learners.</td>
<td>Samples of candles. Observation</td>
<td>Samples of candles</td>
</tr>
<tr>
<td>Replacement for electricity for heat.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The test she had given to the class on 09 May 2001 shows sections of Measurement as well as Vertebrates. This indicates that Grace did not adhere to her original plan to do Vertebrates in the fourth term. The planning as provided in the table above also does not correlate with the learning unit observed. The planning is therefore not practical and realistic.

4.3.3 Annette
Since the new Natural Sciences learning area for Grades 7, 8 and 9 consists of four themes, teachers at Annette’s school decided to make use of team teaching for the Grade 8 and 9s. The Earth and Beyond theme was taught by the Geography teacher; Life and Living was taught by the Biology teacher and Energy and Change as well as Matter and Material were both covered by Annette who is the Physical Science teacher. By implementing a team-teaching approach they made sure that each of these themes were taught by a specialist in the subject field who would have a strong knowledge base regarding the nature of each of the themes. Although there are obvious advantages to this approach, the disadvantage was the lack of integration between the three teachers. Each set his/her own paper for the examinations and projects during the year. There was no investigation that could integrate the concepts in the themes. As a result of the lack of integration, the learners may have partitioned their conceptualisation of the Natural Sciences learning area.

Annette bought a workbook compiled and published as support material for Grade 8 Natural Sciences, which she used as her planning for the year. The workbook also suggested the projects she had given her students. The content and sequence of the activities in the book follows the previous syllabus for Grade 8. Although the workbook is full of activities, worksheets, investigations and questions to test the factual knowledge and understanding of the learners, no critical outcomes, specific outcomes, assessment criteria or assessment other than questions to test factual knowledge have been identified. Annette used the book as
a guide for her activities throughout the year and followed the sequence as set out in the workbook.

The emphasis of the learning activities was on the traditional way of teaching and therefore also traditional written tests with examinations and one or two assignments. After the C2005 training, Annette did decide to focus on learner responsibility for homework as a learner attitude to be developed for the year. Open-ended investigations were not implemented or planned.

In summary, the planning phase of all three teachers participating in the study was not a priority for them. Recordings of planning did not match their respective practice. Since the focus of this study is assessment, it is imperative to report on how the teachers observed and used assessment to facilitate learning in the classes.

4.4 **FORMATIVE ASSESSMENT**

4.4.1 Michael

Michael has a very positive belief in his competence to perform formative assessment. In answer to an item on a questionnaire where Michael was asked to rate his confidence on a scale from 1 – 4, (where 4 was feeling highly confident) Michael indicated that he felt highly confident with his ability to provide feedback to learners. He also felt highly confident to give reasons for making specific decisions about the learners’ competence. The unit observed had no evidence of formative feedback on learners' achievement and their learning. No negative or positive feedback, only motivational comments were written on the written work of learners. It ranged from “Well done to the future Springbok no 12” to “Nice work” and “Neat work”.

Michael missed his opportunities for integrating assessment with teaching through formative assessment. During the introduction to the unit on plants he planned different activities in which the learners could discover the veins of different types of leaves; they could brainstorm different plant words they knew (this could be used as diagnostic assessment to determine their baseline knowledge about...
plants); and lastly he planned to ask the groups about what they had learnt from the experience. All 3 activities could provide opportunities for formative assessment to take place, but the opportunities were not used. Michael did not monitor learning that took place and this changed the nature of the activities from being learning experiences to activities that occupied the learners and kept them busy. The chances that factual knowledge about plants could progress into conceptual knowledge diminished. The opportunity for the establishment of a relationship between prior knowledge and new knowledge also was not captured.

Michael did make use of both groupwork and peer assessment, but closing the gap between what the learners knew and could do and what was expected of them did not receive adequate attention. The objectives for activities were not shared with the learners and where instructions were given, they were vague and created the impression of being unplanned. There was little oral feedback during learning unit activities observed. Michael commented in the interview that he should “be the learners’ last resort for information, only after everything and everybody else had been consulted”.

In conclusion of the description on Michael’s formative assessment practices, it is important to highlight the inconsistency that exists between Michael’s beliefs and his practices. Even though Michael indicated on the questionnaire that he felt confident in his ability to complete the different aspects of formative assessment, he also indicated that he was uncertain about his knowledge of the theory behind the notion of formative assessment. The evidence gained from the observation of his practices indicates that he did not apply formative assessment according to internationally accepted practices.

### 4.4.2 Grace

Although Grace made use of the question and answer technique in her class for most of the teaching observed, numerous opportunities to enter into dialogue with the learners were missed since the focus of the question and answer sessions were not explicitly on formative assessment. The finer aspects of questioning needed to facilitate formative assessment, such as providing thinking time, drawing
out the learners ideas, or encouraging them to explore further, were missing. The following transcript will illustrate how an opportunity for formative assessment and providing support for a learner’s concept about heat conduction was missed.

G: *Is plastic a good or bad conductor of heat?*
L1: *Good.*
G: [Shaking her head] *It can’t be a good conductor. It should be a bad conductor. Give me other examples.*

No explanation was given why plastic is a bad conductor or why the learner thought it was a good conductor of heat. The learners are left guessing the answers and through a trial-and-error method provide the teacher with answers for which she is looking. Over time the learners got the message - they were not required to think and to formulate their own answers: they had to guess the answer the teacher expected. No scaffolding took place in order to improve the learning.

Another example that illustrates missing opportunities to engage with the learners understanding and their meaning-making, is a class activity given to the learners on the concepts “convection and conduction”.

Grace wrote the following question on the board from one of the extra textbooks available in her class.

*Complete the following sentence and choose the correct word between brackets in the other questions.*

1. Heat can be transferred from one point to another by convection and conduction.
2. Which one of the following is the bad conductor (copper, lead, glass).
3. Water is a (good, bad) conductor of heat.

The underlined words in question two are the answers Grace was looking for. The second question is an ambiguous question, since all three examples (copper, lead and glass) will conduct heat, but glass will not conduct electricity. There is no indication for the learners to which property (conductor of heat or conductor of electricity) the question is referring. The learners were requested to copy the questions into their workbooks. There was only sufficient space on the board to write the questions. The rest of the board had the remnants of the lesson. Consequently, learners could have found the answers to questions from the board if they had paid attention. They were also allowed to work in their groups to get the
answers. There were still some learners who had nothing correct or who had two of
the three questions incorrect.

Grace marked the answers individually, which according to Bentley and Watts
(1992, p.16) is a good idea. The answers were marked with either a tick or a cross.
The learners had to do the corrections while she completed the marking. After she
had seen every learner’s book, the answers were discussed with the whole class
and learners with incorrect answers were instructed to write corrections in the class
workbook. The problem was that the discussion took the form of Grace providing
the correct answers, without addressing misconceptions from the learners’
answers.

Examples of some of the answers by the learners in their books were:

L1:  Heat can be transferred from one point to another by hot and cotential.
L2:  Heat can be transferred from one point to another by cooler point and
warmer point.

The learner’s misunderstanding of the word “potential” as “cotential” together with
the “incorrect” answer was not corrected.

4.4.3 Annette

From the three teachers, Annette provided the most substantial feedback on the
projects she had received from the learners. The comments varied, but they
indicated areas where the learners could have done better, such as:

How do they separate crude oil in all its components? You did not mention a thing
about that.
Michael, please come and see me about the mistakes you made in the tasks and
the expectations I had of the task.

Although the comments could be used to improve future projects, the projects were
not given back to the learners for improvement to be re-assessed; neither did the
learners receive another opportunity during the rest of the year to apply the
comments to a new project since it was the last written project for the year. The
comments provided justification for the mark that was allocated. Assessment for
learning (formative assessment) was thus minimised.
The classroom discussions were teacher-driven. Annette had a series of answers that she had planned to receive, she guided the learners in that direction with questions and then she provided the answer she was waiting for.

A: If we want this piece of metal thinner, what could we do?
L1 Flatten it with a hammer.
A: We can thus say that a metal is malleable.
If we hit the charcoal rod with a hammer, what do you expect will happen?
Ls: It will break into pieces.
A: Non-metals can therefore not be bent, flattened. We say they are brittle.

Instead of allowing the learners to come to conclusions, Annette provided the facts. She frequently made use of dictating answers to questions on worksheets as illustrated by the extract. After the concepts of an element were taught the learners had to answer the following question in their workbook:

Try and write in your own words a definition for an element.

Instead of expecting the learners to formulate their own concept, Annette provided them with the answer by dictating it to them: “Elements are the simplest material that exists”. She had to repeat the sentence six times for all of them to copy the answer in their books. This makes the learners lazy to listen the first time and to think about the question. It was easier to wait till Annette provided the answer and in the end their own “meaning making” did not happen.

A: Find H, O, C on the periodic table. They are all non-metals. Draw a circle around them on the periodic tables in your workbooks. [The learners did that.] The periodic table also indicates the phases of the elements at room temperature. The gases are coloured in red on the table, while the solids are black and the liquids are white. Examples of gases are oxygen, nitrogen, helium, hydrogen and chlorine. [The name and the symbol were written on the board and she pointed out the position on the coloured periodic table against the wall.]

A: An example of a liquid is mercury. Examples of solids are Al, Au, C, Ca, Cu, Fe, and Ni. Since it is not in your workbooks, write down the characteristics of metals and non-metals in your workbook. If you look at the periodic table, you see that according to the colour-key used, the left hand side of the table are mostly solids. Therefore, metals are solids. [She completed the table on the board and the learners had to copy the information on a page that they afterwards had to paste in their workbooks.]

<table>
<thead>
<tr>
<th>Metals</th>
<th>Non-metals</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metals</th>
<th>Non-metals</th>
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<td>C</td>
<td></td>
</tr>
<tr>
<td>Al</td>
<td></td>
</tr>
<tr>
<td>Au</td>
<td></td>
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<tr>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Cu</td>
<td></td>
</tr>
<tr>
<td>Fe</td>
<td></td>
</tr>
<tr>
<td>Ni</td>
<td></td>
</tr>
</tbody>
</table>

[The learners completed the table on the board and they had to copy the information as instructed by Annette.]

A: Find H, O, C on the periodic table. They are all non-metals. Draw a circle around them on the periodic tables in your workbooks. [The learners did that.] The periodic table also indicates the phases of the elements at room temperature. The gases are coloured in red on the table, while the solids are black and the liquids are white. Examples of gases are oxygen, nitrogen, helium, hydrogen and chlorine. [The name and the symbol were written on the board and she pointed out the position on the coloured periodic table against the wall.]
1. It is solids, except for mercury, which is a liquid.  

Instead of providing the answer to them, she could have asked learners what they could deduce from the fact that metals are situated on the left of the periodic table, given the fact that they had just learned the positions and examples of solids, liquids and gas elements. She also did not ask them to provide the related characteristic for non-metals if metals are considered to be solids (except for mercury). Reflection on what they had learnt in order to internalise the concepts, had been neglected.

An area where formative assessment was used was with the homework done by the learners. Annette implemented a system where she monitored the homework given to the learners, firstly for formative assessment purposes and secondly to focus on the development of the learners’ ability to take responsibility for tasks given.

A  
I originally just started with: did he do it – one mark. If he did not do it – zero. Then I found that if the task is more complex, developing a bit more...after each section in the workbooks there are “test your knowledge” sections. Then there are a few question they had to complete and then I said: OK, he had eight questions to complete. Then I started giving them more marks. If he did all of the eight questions, two marks. If he did only half of it, one mark. If he did nothing, zero marks. Then you started to bring in a bit more responsibility.

I was scared in the beginning to give marks for correctness. I only started doing that in the second or third term where I individually marked the homework. Then I gave marks for the correctness of the answers. But in the beginning, it was just to teach them responsibility to execute a simple task at home.

E  
How did you handle the feedback or reporting of responsibility to the learners and the parents?

A  
By the allocation of marks.

E  
So, the learner with more responsibility had a higher mark for his science?

A  
Yes.

Although the main aim of the system Annette implemented was to develop the learners’ responsibility towards doing homework tasks, the marking of their answers towards the second half of the year provided her with opportunities for formative assessment. However, providing constructive feedback was jeopardised...
because some of the corrections she made during the marking of the learners’ homework was done inconsistently, as illustrated below: The learner calculated the work done and wrote the answer as $3560 \text{ (joule)}$ with the brackets around the written unit. She corrected the answer by deleting the brackets on two occasions, but in the same homework exercise the following calculation was written down and the corrections indicated. An important principle in science calculations that the physical law used to do the calculation has to be written and that the calculation should be mathematically sound, was not corrected. She corrected the amount used for the force (45 instead of 450), but the other mistakes were not corrected.

As a summary, teachers did not use the formative assessment opportunities that exist (marking learners’ work and classroom dialogue) optimally.

### 4.5 Summative Assessment

Harlen (2000, p.199) stated that summative assessment should refer to the full range of learning goals, as the starting point for the description of Michael’s, Grace’s and Annette’s practices. The range and the variety of activities learners should perform in science make it necessary to use many assessment methods. Summative assessment methods are used to collect information on the learning that takes place at the end of a learning unit, with the intention of providing a level of achievement for the learner assessed. In this section, I focus on the individual assessment types as headings and describe each teacher’s practices under them.

#### 4.5.1 Written tests

Michael’s classes had one written test per term, based on the “chapters” or learning units that were covered during the term. The printed written tests were set by Michael and focussed mainly on factual knowledge. The types of questions that were asked in the tests were of the same format as the content covered in the learning units. Questions in the tests showed that the learners were asked to repeat what was in their photocopied notes. The questions were mostly of a completion type, such as fill in the missing words, with less emphasis on writing a full sentence or a short paragraph to determine the level of the learners’ thinking. Very little attention was given to data response questions or higher order questions.
in Michael’s test papers. The written tests revealed the following questions as representative of the types of questions Michael asked in general:

- Give the correct term for…
- Give examples of…
- Give functions of…
- List two facts about…

In the test, (see Appendix B3 for the full test) Michael asked the following question:

*By means of a sketch and labels, indicate the difference between a shark and a fish with regard to:*

1. breathing  
2. mouth.  

(4)

On the same page, a drawing of a shark was included. From the drawing, the general position of the mouth and the gill slits was clearly visible. A lack of clarity of expression is again evident when only the word mouth was written in the second part of the question and not a concept such as the position of the mouth. A learner can very well ask: What about the mouth? The example set by Michael, as role model, is that attention to detail is not important in learning science: as long as you have the general idea it is fine. This was then reflected in the answers that Michael accepted in the tests, such as the answers to the following question.

*List two facts about a crocodile’s eating habits.*

The answers of two learners were:

- **L1** carnivorous (eats only meat)  
  Sharp teeth (tear of flesh)  
  Powerful jaw  
- **L2** They have sharp teeth and eat large amounts.

The learners’ ability to construct a meaningful and logical answer was not assessed and Michael was satisfied as long as they had a general idea of what the question was about.

The tests did not encourage the development of writing more than single words or at the most a phrase. Generally, questions expected only one-word answers from the learners. When a full sentence was required, phrases were accepted. The
assessments are not valid – they do not assess the full spectrum of the Natural Sciences learning area goals as expected from them, but only focused on the knowledge domain of science knowledge.

Grace also made use of written tests for collecting summative assessment evidence. The school cannot afford to make a photocopy for each Grade 7 learner every time a test is written. Grace therefore wrote the test on the board with two sections that could be opened or closed. By writing the test on the board at the back and closing the two front sections, she could keep the test on the board until all the groups had written the test. This limits her to a narrow selection of questions and inhibits the use of full sentences in the test questions. She is therefore confronted with the same situation regarding the writing ability of her learners as Michael’s learners. Since the teacher does not practice full sentence writing, the learners do not answer in full sentences either. (Grace’s tests appear in Appendix C).

When comparing the mark allocations of Michael and Grace, Grace allocated double marks every time, while Mark allocated only one mark per fact identified by him. Michael also gave the learners an indication of the mark allocation on the question paper, while Grace’s test on the board did not have any mark allocations.

The written tests set by Annette for the Grade 8s are more in depth, in terms of the type of knowledge expected as well as the type of question asked. She made use of multiple choice questions, one word for the statement, True and False questions, a response question as well as a data response question based on a laboratory investigation. An extract of her test is included in Appendix D-1. The test aimed to assess a range of learning goals, from the memorisation of factual knowledge to the understanding of factual knowledge as illustrated by the question: Name two reasons why you would classify an ice cube as matter and two reasons why you would classify it as a solid.

All the tests contributed towards the summative mark for the learner at the end of the year. The emphasis of written tests was on the collection of evidence for
summative purposes, with no emphasis on the possible formative use of such assessment evidence.

Michael and Grace each made use of a written test to assess the practical skills of their learners. Only one “practical test” was written by each of them during the year. Both Michael and Grace’s tests are included in Appendix B-1, B-3 and C-1, C-2, C-3 respectively. Grace asked her learners to do a calculation for the practical test and to identify the name of the technique used to determine the volume of an irregularly shaped body. For Michael the recognition of the instruments of measurement such as a pipette, burette, measuring cylinder and the fixed arm balance as well as the particular situation in which you would use each of these instruments, counted as a practical test.

Although Annette also assessed the practical skills with a written test, she moved away from the narrow focus on knowledge and made use of a variety of questions to collect the evidence. The examination papers were set using a combination of the following question types: Multiple Choice questions; True and False; Fill in the Answer; Write a paragraph; Data response questions; and Translation questions. In her written examinations, she integrated the application of process skills such as classification, interpretation, text analysis and the application of ideas and knowledge in new contexts. A selection of the examination questions is included in Appendix D-1. A comprehensive spread of the learning goals were assessed in the examinations for the Grade 8s during the year the observation was done. Knowledge as well as the application of knowledge was assessed, the demonstration of practical skills was assessed through “minds-on” assessment tasks and the social contexts and everyday life contexts were covered as well. This is illustrated by what follows from the November examination paper.

Annette adapted an article she found in a popular science magazine to an alternative assessment tasks for the examination. The article discussed the metal aluminium, its properties, the difference between aluminium and steel tins and lastly aluminium and the environment. The adapted article is attached in Appendix...
D-2. She built a comprehensive list of question types around this article of which I will discuss two.

Write a short paragraph in which you explain what you can do to prevent pollution in your environment. You may use some of the ideas in the article.

This question asks learners to address an environmental issue that will provide Annette with evidence of the learners' attitudes towards pollution. The article provided ideas that are “hidden” and not explicitly pointed out as actions to prevent pollution. The learners had to read the article and use the information in a new and personal context.

You are collecting tins with the purpose of selling it to a person who wants to recycle the tins. There are aluminium and steel tins. Name two methods you may use to sort the aluminium and the steel tins fast and effectively.

The properties of aluminium and steel tins were provided in the article by using labelled sketches as well as a description of aluminium's properties. The question expected learners to apply this information to the separation methods they had done during the term.

Although the practical work had only been assessed summatively by the allocation of an average mark for the learning outcome, the different question types used during the examination, collected evidence of the achievement of a variety of skills. The written assessments succeeded in integrating conceptual knowledge, skills and attitudes in the summative assessment opportunities. This serves as evidence of the strength of her subject knowledge, which enabled her to extend her learners.

4.5.2 Worksheets
Michael used worksheets that were of the “fill-in” format. The worksheets formed part of the learning units. Most of the worksheets used during the year as part of the observation data collection were commercially produced worksheets, used as is. He provided each learner in the class with a photocopied worksheet that they had to complete, beautify and staple with the other photocopied information he had
provided. This formed their learning unit. The worksheets were marked and graded as part of the learning units when such learning units are completed. No criteria for the assessment of the worksheets were written or were provided for the learners in advance. The self-assessment that was part of the “chapters” had criteria and the learners knew what they were. An impression mark was provided for the “chapters” which included the worksheets. Based on the comments provided by Michael, the neatness of the learning unit and the effort put into beautifying it carried a heavy weighting. “Neat work; “Nice”; “It is a pleasure to mark such neat work”.

Once again, Grace cannot afford to freely copy worksheets. The learners each have to pay a fixed amount of money before they can get a photocopied page. As a result, she has the added responsibility to select the best worksheet to be photocopied. As far as possible, Grace taught without having to provide photocopied pages. This lead to a phenomenon where the instructions and assessment criteria were repeated over and over as if she was creating “worksheets in the air” (Naidoo, 2001, during a personal conversation). There was also a great deal of writing on the board.

Her learners then answered the questions in their workbooks, which she marked individually or occasionally she would let the class mark each other’s answers while she provided the correct ones. This was the extent of peer assessment in her classes. Even in those cases, she would still sign each individual’s workbook. Mostly the learners only wrote down the answers in their workbooks, without copying the questions as well. The learners only had a record of the answers and not the questions. Therefore, these exercises could not be used as a resource for later revision of the work. Those worksheets or classwork as it is called in Grace’s school will be graded and the marks recorded for the year mark. The purpose of the worksheets, as is the case with Michael’s worksheets, is summative.

Annette also used worksheets, but her worksheets were developed and bound in the form of a workbook, which each learner in the class had to buy. She followed the book as a form of a syllabus. The worksheets are a combination of practical exercises, questions to answer regarding the topics and assignments. Annette
used the worksheets for homework and to develop responsibility regarding the performance of a task given (This has been discussed in section 4.4.3). Although the assessment of responsibility may appear to be formative assessment, this performance was converted into marks to be incorporated into the accumulative mark at the end of the year. This changed the opportunity for formative assessment into ordinary summative assessment. The information collected regarding the learners’ responsibility was not used to make formative decisions on how to address identified weaknesses: it was recorded as a final summative assessment.

4.5.3 Projects
Projects are defined as culminating experiences and activities designed to bring together a number of strands in a unit. As culminating activities, projects consist of higher-order objectives, which are integrative in nature and thus, should have a focus (Trice, 2000, p.202).

Grace gave her learners what she called a project during Term 2 that was based on the learning unit “Reptiles”. She reported that she wrote the instructions on the board and the learners copied it down. The learners could copy the requirements on any piece of paper – she did not check the correctness of the information they wrote down. Since the instructions were written on the board and they were cleaned by the time that the observation period started, no written record existed. During an informal interview, Grace indicated that the instructions to the project were:

“Draw the life cycle of the frog on half of the poster paper and then answer the following questions on the other half of the paper:

1. Define an amphibian.
2. Define the word habitat.
3. What is the habitat of an amphibian?
4. Describe the body division of an amphibian.
5. What is the body covering of an amphibian?
6. What is the locomotion of an amphibian?
7. What reproduction do the amphibians have?
8. What do they use for respiration?”
The learners did not have to reference the information and used their textbooks to find the information. The “project” does not bring together a number of strands in the learning unit. The illustration of the life cycle received an impression mark and the questions were marked out of eight and then converted to a percentage. The average between these two percentages was recorded as the final mark for the product. Grace made no corrections on the posters themselves, although an analysis of different learners’ products indicated that the beautification of the poster (which did not necessarily have to be relevant) received good marks as did the size of the sketches drawn for the life cycle. The allocation of marks was not consistent. One answer from a learner to the first question was:

_Amphibian is an animal that lives in water or land._

While another learner answered:

_An Amphibian is an animal that lives in water and land._

The first answer received one mark while the second answer received half a mark. The same variation in mark allocation was observed for the second “project” that Grace gave her learners.

The second “project” was based on the learning unit: “Vertebrates”. Learners had to work in groups. The table was written on the board. Learners had to complete the table and each learner in the group received the same marks for the chart. Grace completed the information on reptiles to illustrate the kind of information that she wanted.

Under the heading “Drawing” the learners had to draw an animal from that animal class. They were not allowed to paste a picture.
Table 4.3  Grace: Vertebrate Project

<table>
<thead>
<tr>
<th>Class</th>
<th>Drawing</th>
<th>Body Covering</th>
<th>Appendages</th>
<th>Locomotion</th>
<th>Respiratory Organs</th>
<th>Reproduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amphibians</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reptiles</td>
<td></td>
<td>Scales, dry skin</td>
<td>Four legs</td>
<td>Walk, run</td>
<td>Lungs</td>
<td>Oviparous</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ovoviviparous Unisexual Internal Fertilisation</td>
</tr>
<tr>
<td>Birds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mammals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Grace indicated during an interview her rationale for assessment criteria she gave the learners:

*I focussed on neatness, spelling, drawing, correctness of the information as well as the accuracy of the learners - do they make careless mistakes, for example, spelling a word correct and then incorrect on the same chart.*

She also mentioned that the assessment criteria “were more or less equally weighted”, but it was not communicated to the learners. I found one chart of a group on which Grace wrote the following on the back of the chart:

- **Drawing**: 60%
- **Presentation**: 68%
- **Neatness**: 50%
- **Knowledge**: 52%
- **Average**: 58%

This provided evidence that the assessment criteria were all weighted equally, but Grace indicated that she felt uncertain of the meaning of weighting and the application of it in the classroom. The marks earned for the chart were allocated...
equally to all the group members. No marks were given for any individual’s role in the group.

Michael’s project was more complex in terms of the integration of the different aspects of the learning unit. Although it may appear to have been more formal and more structured, the instructions were also given to the learners orally and the assessment criteria were also provided verbally. This indicates that clear instructions and assessment criteria are not a priority for Michael, whereas Grace had no choice other than to provide her learners with verbal instructions and criteria. Michael presented the following project instructions to me. The learners had to complete the project individually.

1. **Topic.** Choose any relevant General Science topic. Topic must be goal directed, i.e. focus on something; i.e. Don’t do Whales - do Migration pattern of whales.

2. **Format:** (10)
   a. Front Page. - Name and grade should be in the top right corner and the title should be in the middle of the page. 3 marks will be allocated for this and the rest of the 7 for overall impression.
   b. Contents Page. (10)

   c. **Body.** (30)
      This is the content of the project. The content needs to be on your level.
      2 pages written or typed, including pictures and sketches.
[The sketches provided by Michael imply that the pages should be numbered at the top & centered; the headings should be numbered and underlined. Two lines should be left open between each new paragraph]

3. **The Poster/Model:** (20)
   This should be functional and serve a purpose.

4. **Interview:** (20)
   This will happen one on one.
   The teacher will ask relevant questions to see whether the learner knows the topic.
   Learner must be able to tell the teacher why (s)he chose the topic as well as one or two general questions about the topic.

5. **Overall Impression:** (10)
   Overview of project/talk in terms of neatness/correctness/effort.

Total: 100 / 2 = (50)

Michael’s emphasis or preoccupation with converting all assessments to a particular mark for his record book became evident when he converted the project’s marks which were out of 100 to a mark out of 50 since that is what he needs to record in his book. He does not work with percentages, but with marks that represent the weighting in his record book. If a test has a weighting in the record book of 20, then the test will count out of 20.

Annette also provided the learners with two projects that were suggested in the workbook that her learners used. Topics were suggested in the workbook, but no assessment criteria were indicated. For the first project, Annette asked learners to build a functional scale from cooldrink tins. The instructions she gave the learners were:

*Use a tin, cut the top and bottom of the tin away with a pair of metal scissors, and use the lids for scale-pans. Follow the sketches to complete the scale.* (Sketches on how to complete the scale were provided in the workbooks and are included in Appendix D.3)

The project was assessed on the following criteria:

- Real life resemblance;
• Functionality [from the interview the conclusion is that this was more a
demonstration of the learner’s ability to operate the balance];
• Effort put in; and
• Time-management.

All the criteria were not weighted equally, with the emphasis (highest marks) on the
skill of operating the balance, which is the criterion Functionality. The building of
the balance happened in groups of two, while the demonstration of the ability to
weigh an object with the balance was done individually. Again all the instructions
and criteria for the project were given orally. The levels of progression or a
description of what the criteria entailed were not included; neither did the learners
receive an idea of the weightings of the different categories towards the final mark.

A: With the concept of mass, we let them make a balance. A balance made out
of two balance pans…We used a set of real weights. I provided them with
an eraser and told them to weigh the eraser with their own balance, since
the balance had to function properly and they should form the concept of
how you should weigh with such a balance scale.

E: Did you judge the aesthetics of the designs?
A: I did allocate a few marks for looks, does it look like a balance. So, I did
allocate marks for effort…did he put in effort to complete the balance and
then I looked at whether it worked. Does it have the potential to function as
a balance? Then each learner had to physically demonstrate the balance
and operate it. I also gave marks for that. So, this project had those three
aspects. He had to make the balance and it should be functional. He had to
demonstrate the operation of the balance. This is then all integrated into a
percentage.

E: Did you decide before the time on the weighting of each component?
A: I gave a mark for handing it in on time and whether he did submit. Not
handed in on time – zero. If he handed it in on time, it was a mark.
Then…three marks…were allocated for the looks and the effort put in. Then
I gave five marks for the demonstration and the weighing of the eraser and I
think about two or three marks for the functioning of the balance. They
received in the end about fifteen marks. So the aspects were not equally
weighted. The most marks went for the operation since that is also an
individually earned mark.

Annette found that she struggled to collect a balance from every group. Some of
the learners did not submit their projects, even after she regularly gave extensions
on the due-dates. The learners that handed-in very late were penalised with more
than just the original one mark penalty she planned to use. She eventually
allocated a few zeros to learners who did not hand in their projects.
The second assignment that Annette gave her learners was to illustrate one of the separation techniques as it is used in the industry and discussed in the classroom. The learners had a choice to either present the information in the form of a poster or in the form of a written assignment. An assessment grid was used for the assessment of the projects, but the grid was not discussed and explained to the learners before they started with the project. The grid is provided in Appendix D.3.

4.6 IMPLEMENTATION AND ASSESSMENT OF GROUP WORK

The use of group work provides the teacher with the opportunity to listen to the discussions of learners in their quest for meaning making of the classroom activities, but also provides a safe context for learners to test their ideas. Group work has also been suggested as one of the methods to employ during scaffolding for formative assessment purposes (Sorensen, 2000, p.127). Assessment of group work is a thorny issue (Trice, 2000, p.219). There is consensus that co-operative learning is good for students, and that it needs to be emphasised in the classroom. There is less consensus on where it fits best and very little consensus on how to assess co-operative learning. The teacher’s philosophy of teaching and assessment as well as the realities of the classroom determines how we assess group work. The options are to teach co-operatively and assess individually, assess so that part of a student’s evaluation is based on the group’s accomplishment, or assess entirely on group work. This statement is illustrated by Michael’s decisions on the assessment of group work in his classroom.

M:  

We basically cannot provide them with a mark for it [group work] since the reports do not allow us to do so. You only get a tick, a dot or an arrow [on the report]. Your tick says for example 80% or more co-operation and your arrow is satisfactory, basically your 60 – 70%. And then you dot is 50% or less. In other words if the learners receives a tick on his report for co-operation, that learner does not know if he had 81% or 99%. He only knows that it is between 80 and 100. We used the scales they provided us with on the OBE meetings. We work according to that.

4.6.1 Michael

Although Michael’s school did not have a written school policy they identified co-operation and the ability to work in groups, as some of the skills the Grade 7
learners have to display since that was required in the new report system they had implemented. This facet was assessed by each of the learning area teachers and a combined mark was reflected on the report. Michael also put emphasis on the social issues in teaching and is very aware of this in his class. This is evident from the following remark:

M: I re-shuffle my groups at the end of the term. They have new groups every term. We have at the end of the term, learners that work together very effectively, they are friends, but they do not cause problems. I actually feel sorry for them, but you have to re-shuffle because you have to learn how to get along with everybody. That is now again the whole idea where you have to develop the attitudes and values.

Michael assessed the co-operative functioning of the groups by means of self-assessment and peer-assessment. The focus of the assessments was on social skills and task skills. The assessment results are converted into a mark out of 10 and then recorded as part of what the school calls the continuous assessment mark for the year. Every learning unit done had a component of co-operative learning or group work assessment in it, but the evidence collected from the assessments was neither followed through nor used in future planning or monitoring the development of learners in a particular area. This diminished the formative value of the technique and it became a summative collection of assessment evidence.

Michael used two sets of assessment tools for the assessment of group work. Figure 4.1 focused on the co-operative group skills in the form of a checklist and the learners providing a mark on a key of either 1 (the skill is present) or zero (the skill is absent). Figure 4.2 was more open ended and asked for responses and reflection from the learners. Both of these assessment tools were part of the support material provided by the DoE at the one-week training session for the implementation of C2005.

Mainly the group members did the assessment of the co-operative group skills as peer assessment. Although the functioning of the groups was assessed on a continuous basis, the information collected was not used for further learning. One
of the assessment sheets recorded by a learner provided the following assessment
evidence to Michael:

What could we do better? The poster
What went well? Not much
What I did: Spoke about the care and management of trees.
Helped with nothing.

<table>
<thead>
<tr>
<th>Co-operative group skills</th>
<th>Groupwork</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Task skills</strong></td>
<td>Did your group:</td>
</tr>
<tr>
<td>• Give ideas</td>
<td>Yes    No</td>
</tr>
<tr>
<td>• Asks questions</td>
<td>LISTEN to each other?  □ □</td>
</tr>
<tr>
<td>• Stays on task</td>
<td>TALK about the task?  □ □</td>
</tr>
<tr>
<td>• Follows directions</td>
<td>CO-OPERATE?  □ □</td>
</tr>
<tr>
<td>• Check’s others’</td>
<td>SUGGEST good ideas? □ □</td>
</tr>
<tr>
<td>understanding</td>
<td>ENCOURAGE each other? □ □</td>
</tr>
<tr>
<td>• Gets group back on task</td>
<td>What went well?..........</td>
</tr>
<tr>
<td></td>
<td>What could we do better? ........</td>
</tr>
<tr>
<td><strong>2. Social skills</strong></td>
<td></td>
</tr>
<tr>
<td>• Encourages others</td>
<td></td>
</tr>
<tr>
<td>• Explains ideas</td>
<td></td>
</tr>
<tr>
<td>• Discusses</td>
<td></td>
</tr>
<tr>
<td>• Listens well</td>
<td></td>
</tr>
<tr>
<td>• Praises others</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.1 Co-operative group skills assessment sheet. Figure 4.2 Self-assessment: co-operative work. Group assessment.

Michael did not follow-up on the assessment evidence he collected on the group-assessment sheets. No feedback was given nor any remedial actions planned for the areas where the learners indicated that they could improve in. The completion of the assessment task did not aid the further learning and development of the learners. They could have perceived the task as senseless and therefore also did not care to provide the teacher with a true insight of the learning process.

Michael used the assessment of group dynamics as a component of the overall assessment of the task he has given of the learners as illustrated below.

M: Sometimes it is only internally in the group, peer assessment of their own group. Other times I rotate the groups around. Then they assess each other’s groups, and then we take the average of that mark, which is a bit more
balanced. And then the third one is the individual one where I observe myself. I allocate a mark for the group; then I also ask the group members to assess each other – according to your effort and that. During my observation I make small notes – this child walks around in the class. Just now he complains about the low mark he received, then I can tell him but you walked around in the class. That is why you received such a low mark. I gave them a task a while ago, which counted out of forty. I divided it in two, I gave a mark and then the partner gave a mark for the group member. Then I took the average of their mark and my mark.

4.6.2 Grace

The composition of the groups in Grace’s class was permanent for the year. Learners knew each other and a relationship developed between them. Grace rotated between learning taking place as a whole class, learning in a group and learning taking place as individuals. She succeeded in balancing the use of group work with that of individual work. The groups in School 2 worked more on an “expert model” (Trice, 2000, p.220) where each learner discovers the role for which he or she is best suited (for example doing all the drawings) and becomes an expert. The choice of this model happened by default, since not all the members of the group could contribute in the same manner. Some of them had access to crayons, another one had an eraser, while one of them could draw. As the socio-economic situation of the community was such that not every learner had access to the same or all the resources, they were dependent on each other to provide bare necessities for the task. True co-operative learning with mutual interdependence thus happened at School 2.

Grace did not make use of the opportunity to assess the group dynamics during the observation period or during the first half of the year. She only marked the group project she had given the learners and allocated the same mark to every member of the group. One of two groups did complain about a member who did not co-operate, as they should, upon which she reduced that particular group member’s marks slightly for the project.

4.6.3 Annette

Annette seldom uses groupwork during her theory classes, partly because the physical layout of her classroom did not allow her to do so and partly because she...
used a teacher-centred approach to teaching. She did make use of groups during practical work in the laboratory. The forming of the groups is based upon ability and familiarity with equipment such as electrical components. She explained her choice and argued that this arrangement leaves her with the opportunity to provide assistance to the groups that do not work as fast, while the learners that could carry on independently are functioning on their own. By employing ability grouping, she can spend more time with the learners who struggle, while the faster workers can carry on with the task.

A They were strange for each other. They were all new in the school. But I did realise that you should not keep friends in the same group. I would next year find out who were from the same primary school and rather divide them in different groups, separating them a little.
I So the benefit of this activity was that the learners started to know each other.
A Yes.
[This is an indication that this is the first time that Annette is using groupwork.]

A Towards the end of the year, I worked in groups again when we covered electricity. I then grouped them according to academic achievement. There were one or two that mentioned that all the slower learners are now grouped together, but I explained to them that the one group can carry on with their work on their own. That allowed me to help those that had a little bit of difficulty. In that way I tried... there were very enthusiastic groups, they worked together and progressed. And then there were those, which were strange since they were of the middle group, where you had one guy that totally dominated the group. The rest just sat back. But I could reach the weaker learners personally. Interesting enough you provided a weaker learner an opportunity to take the lead, which had its own benefits. You will then observe them and take note who functioned well and who not. They will receive bonus marks, but it is a very time-consuming activity.

4.7 CONCLUSION
Classroom-based assessment of science should allow for the collection of evidence from the full range of learning goals set for the learners with a balance between formative and summative assessment as needed by each individual learner. It is essential that the learning goals be explicitly stated at the start of a learning experience. It was found that since the goals were not reflected upon, the use of impression grading prevailed and teachers were vague about what they planned to teach and to assess as well as about the assessment criteria that would be used.
The three teachers observed displayed a general tendency to have a narrow focus in terms of collecting a variety of evidence of learning and they missed a substantial number of formative assessment opportunities as well. Detailed planning needs attention before remedial action can be taken based on the assessment information collected. A common practice found in the lower grades of the senior phase was that they generally overemphasised the neatness of the learners’ work at the expense of grappling with conceptual understanding. Emphasis on written test responses for the assessment of factual knowledge is common in both primary schools and the secondary school. The focus was more on the attainment of a mark than on assessment for learning.

Lastly, the participant teachers tended to give assessment tasks and then failed to take the results of the assessment into account when making decisions. The assessment information collected is not used for further planning purposes or remedial work, or to make sense from it. Smith & Goodwin (1997, p.114) argue that real assessment lies in making sense of the information that is accumulated.

This chapter described the assessment practices in real life classrooms in South African schools. This answers sub-question 1 and provided the backdrop for the interpretation of policy documents addressing science assessment, in the next chapter.
Chapter Five
Document Analysis

5.1 INTRODUCTION

In Chapter 4 the assessment practices of three senior phase science teachers were discussed in answer to sub-question 1. In this chapter, sub-question 2 will be answered by analysing the developments in the context of assessment in South Africa using a selection of documents. By using the documents published by the national DoE together with a selection of in-service training material published by the Eastern Cape DoE a sample of the appropriate documents was chosen. The selected documents will help to establish the expectations of education in general as well as those expected of science teachers in the senior phase of the GET band in particular.

South Africa is embarking on a radical curriculum change that aims to implement a learner-centred outcomes-based approach to education. Assessment is an essential element of an outcomes-based educational system. Since the change is so radical, most science teachers did not have the opportunity in the past to develop the competences embedded in this change. The South African government has therefore put in place a comprehensive array of new policies and legislation for the professional development of teachers. This forms a central theme to the document analysis.

In order to provide structure to the analysis, the South African Educational System has been categorised according to the “layers of influence” on the assessment practices of a teacher:

- The concepts that govern the organisation of the educational system and the values underpinning assessment in the NQF;
- The concepts of pedagogy that drive the learning programme design, delivery and assessment in Curriculum 2005 (C2005); and
- The concepts of pedagogical content knowledge that specifically drive the assessment of the Senior Phase Natural Sciences learning area.
An analysis of the documents of NQF and SAQA will determine what is expected of an assessor in the South African Education system. The focus will then shift to the interpretation of the NQF principles by the national DoE for use in C2005. The provincialised documents of the Eastern Cape DoE will also be compared with the national DoE’s interpretations. Lastly, the focus will move towards the science classroom and the assessment practices of teachers in the senior phase.

5.2 THE NEED FOR LEGISLATION

South Africa established a NQF, which is administered by the SAQA. The rationale for the establishment of the NQF is embedded in the need to align the South African Education and Training system to emerging international trends of best practice (SAQA, 1999a, p.3). In the SAQA Act (DoE, 1995c), there is an underlying commitment to a system of Education and Training that is organised around the notion of learning outcomes. South Africa’s commitment to OBE reflects a global trend evident in countries in Europe, the Pacific Rim, Australia and North America (SAQA, 2000b. p.4). OBE places much greater importance on teachers who have the skills, not just the knowledge, to teach and to assess (DoE, 1998, p.113) since OBE is essentially an assessment driven educational framework.

Changes in the assessment system started as early as 1995 with the introduction of continuous assessment to prepare the teacher for the move towards assessment in an OBE system (Siebörger, 1998, p.26). However, the White paper on Education shows that, traditionally, continuous assessment has not counted much for promotion of learners from one grade to another (DoE, 1995a). The implementation of continuous assessment in 1995 was also not officially monitored with the result that some teachers implemented it while others opted not to. The lack of teacher preparation for implementing the continuous assessment system in South Africa was reported in the National Policy on Teacher Supply, Utilisation and Development (DoE, 1997b, p.31).

Nationally, the DoE (1997a, p.47) acknowledged that teacher competences in making learning achievement judgements should be developed for the implementation of the NQF. In response to the final COTEP (1998, p.47)
document’s acknowledgement that the assessment practices in South Africa are really underdeveloped, the Norms and Standards for Educators developed roles for teachers of which the role of assessor is one (DoE, 2000b, p.9). Since the NQF is essentially an assessment driven framework (SAQA, 1998, p.4), the development of innovative assessment practices is considered as crucial to meeting the goals of the NQF. For this reason “improved expertise among educators in designing, developing and using appropriate assessment instruments, must be given priority” (SAQA, 1998, p.10). In the “Guideline for the assessment of registered unit standards and qualifications”, published by SAQA (1999a, p.2) there is a stated need to link assessment practices to an outcomes-based education and training system and also to the NQF.

5.3 CONCEPTS UNDERPINNING ASSESSMENT IN THE NQF

The concepts that govern the organisation of the system and the values underpinning assessment in the NQF are spelled out by SAQA in two documents, namely, “Guidelines for the Assessment of NQF registered unit standards and qualifications” (SAQA, 1999a) and “Unit standards for the assessment of learning” (SAQA, 2000a). Although these documents have been used as core documents, they were supplemented by supportive documents to elaborate on certain points.

The NQF provides the basis for all educational qualifications in South Africa. In the framework of the NQF the qualifications are divided into 12 fields of which Education is Field 5. In the education field the GET band is the first compulsory education band with an exit certificate at the end of Grade 9 (The General Education and Training Certificate). It is thus important to align the assessment practices of teachers with the umbrella body of the education system, the NQF, and with SAQA’s interpretations of the NQF principles since SAQA administers the implementation of the NQF principles.

The objectives of the NQF contain principles for the new education system in South Africa that will have a direct impact on the assessment practices in the educational system. Furthermore, the NQF is an outcomes-based education and training (OBET) framework. Assessment practices and procedures for the NQF cliv
have to be aligned to those of an OBET system. The NQF principles and the OBE principles that affect assessment practices will be addressed in paragraphs that follow.

The **principles** of the NQF (SAQA, 1999a, p.3) will be reflected in the classroom-based assessment practices when the following aspects are addressed:

- Integrated assessment;
- The recognition of achievements;
- Legitimacy and credibility of the assessment outcomes; and
- Flexibility of assessment procedures.

In the paragraphs that follow, the implications of each of these principles for the GET band teacher in a science classroom, will be discussed.

The principle of **integrated assessment** refers to the specific form of assessment that permits the learner to demonstrate applied competence (the ability to put the learning outcomes in practice in the relevant context). SAQA proposes that an integrated assessment model includes a balance of formative, diagnostic and summative assessment methods (SAQA, 2001, pp. 30, 31; SAQA, 2000a, pp. 28, 29; SAQA, 1999a, p.4). Integrated assessment in the context of classroom practice is interpreted as assessment that “must include an integration of knowledge, skills and values which is applied in practice in a specialised context” (COTEP, 1998, p.25). It requires an evaluation of a learner’s ability to integrate knowledge and skills rather than assessing the cognitive and performance mastery of one learning area only. Integrated assessment relies on the judgements of assessors. Since the evidence will include evidence of an oral and of a written nature, as well as some kind of performance, it is imperative that integrated assessment should make use of a variety of assessment methods and instruments (SAQA, 1999a, p.4) to be successful in both summative and in formative contexts as pointed out in the previous paragraph.

Under the principle **the recognition of achievement**, assessment should be considered in relation to the learning outcomes, rather than on what was presented
in the course of delivery (SAQA, 2001, p.6). With reference to a classroom context, SAQA suggests that the time of assessment should be an indication of the readiness of the learner for summative assessment and not the length of teaching/learning time spent towards the development of the outcome. An agreement will have to be reached on this principle as a result of externally determined time-lines in the calendar of a school. This principle has another dimension in the context of OBE, namely to recognise achievement. Criteria for the assessment of the achievement should have been identified during planning (DoE, 2002a, p.4). The outcomes to be addressed should be stated before the development of the teaching and learning activities are planned. This principle consequently links with the notion of assessment validity.

Assessment validity is the focus of the next principle SAQA refers to as credible assessment. A credible assessment system, that lays the foundation for the fair, reliable and valid assessment of learners and their achievement, is crucial for the NQF (SAQA, 2000a, p.5). **Legitimacy and credibility** in assessment is ensured through assessment procedures and practices that are governed by fairness, validity, reliability and practicability (SAQA, 1999a, p.7). As assessors, teachers should be appropriately experienced and have the capacity to provide legitimate and credible assessment. SAQA interprets **fairness** in assessment as assessment that does not in any way hinder or advantage a learner. To be considered fair, the assessment process should be transparent, clear and available to all learners (SAQA, 1999a, p.7). Achievements aimed at, namely the learning outcomes, should be explicit and transparent. These clear statements also assist in establishing the **validity** and practicality of assessment methods and instruments used. The assessment methods and instruments used for integrated assessment should allow appropriate and sufficient evidence to be collected (SAQA, 1999a, p.7) in order to ensure validity. **Reliability** of assessment is ensured when specific learning outcomes and their accompanying assessment criteria are the basis upon which assessment is planned, developed and administered. If the outcomes and assessment criteria are specific, are known and are clearly understood by all affected, they can act as in-built mechanisms against assessor inconsistency (Mokhobo-Nomvete, 1999, pp.124,125). This links reliability of assessment
practices back to the principle of fair assessment. Issues of fairness, validity and reliability are also the concern of OBE assessment. Emphasis is placed on explicit, transparent and distinct outcomes (DoE, 2002a, p.4).

In order to ensure credibility, SAQA suggests that when designing, planning and administering assessment, assessors should take available financial resources, equipment and time into account in order to ensure that the assessment is practical (SAQA, 1999a, p.8). By balancing all four aspects (fairness, validity, reliability and practicability), assessors can ensure a credible assessment system. The last principle of flexibility in assessment addresses the following aspects. Flexibility implies the use of a variety of assessment approaches, methods and instruments that are fair, reliable, valid and practicable (SAQA, 1999a, pp. 4, 5) as discussed in the above paragraphs. The opportunity for the use of various instruments and methods is applicable in both formative and summative assessments (SAQA, 1999a, p.11).

In Chapter 2 it was noted that Pahad (1999) emphasised that the use to which assessment information is put will determine whether or not it is either formative or summative while Harlen (2000) emphasised that summative assessment should be based on evidence collected from the full range of learning goals through the use of a range of assessment methods and instruments. Bell and Cowie (1999) pointed out that effective teachers use a variety of means when they assess formatively. These ideas are re-iterated in the policy document:

*This notion of summative assessment [that it should be done on a continuous basis during the total learning experience] allows for the use of a range of methods (observation, product evaluations, written and oral questioning) and a range of instruments (practicals, role plays, written assignments, test, examinations, demonstrations, projects, case studies, simulations, etc.). Furthermore, evidence for this summative assessment can be collected from a variety of sources (SAQA, 19999b, p.11).*

Flexibility in the context of OBE refers to creating a “multiple opportunity” system of instruction and evaluation or in SAQA terminology “expanded opportunities” (SAQA citing Spady, 2000a, p.6; DoE, 2002c, p.4) for assessment. The national DoE
explains the use of expanded opportunities in their “Curriculum 2005 Assessment Guidelines” (2002a, p.4) as:

*Educators must find multiple ways of exposing learners to learning opportunities that will help them to demonstrate their full potential in terms of knowledge, skills, values and attitudes.*

According to the Eastern Cape DoE (2000a, p.14), this principle implies that learners must be given the opportunity to achieve a given outcome in a variety of contexts (through a variety of different types of activities) until the learner experiences success. The national DoE (2002a, p.16) points out that, in consultation with their teachers, learners should be allowed to redo tasks and resubmit their work for assessment by the teacher. By implication, a teacher should have a working understanding of the subject and of fair assessment approaches so as to assess the achievement of the learners in a variety of contexts without penalising or advantaging the learners.

An underlying principle of Outcomes-Based Assessment is criterion-referenced assessment (SAQA, 1999b, p.10), which is in contrast with the traditional norm-based evaluation (discussed in Chapter 2). The assessment criteria become the vehicle to achieve the capacity to construct and achieve outcomes in other circumstances. The assessment criteria are statements that will provide evidence teachers need to look for in order to decide whether a specific outcome or aspect thereof has been achieved. This aspect will be re-visited in the next section.

In summary the impact of an OBE approach and the NQF principles required from a classroom teacher, requires that the following aspects need to be addressed by teachers:

- The assessment process should be regarded as part of the learning process and not as a means in itself, therefore, it should be integrated throughout the teaching and learning process;
- Learners should be given the opportunity to provide further evidence of achieving outcomes at various competency levels (multiple opportunities);
- Learners should be assessed against the criteria in the learning programme.
(recognition of achievement);

- The assessment process should be participative and transparent (credible assessment); and
- The assessment should focus on what learners know, can do and how generic abilities are integrated to demonstrate achievement (integrated assessment).

The national DoE had to interpret the characteristics of OBE and the principles of the NQF in developing the framework for C2005 for the GET band. At the same time, the provinces had to take ownership of such legislation. Therefore, it becomes important to analyse national policies and legislations as well as those of the Eastern Cape DoE’s legislations for similarities as well as variations in interpretation of these principles. Teachers will need to be accountable if they are to provide evidence of learners’ achievement as specified by the national DoE as well as the Eastern Cape DoE.

5.4 Pedagogical Concepts for Assessment of Learning Programmes

A new curriculum, C2005 (DoE, 1997a) was implemented for the GET band of the NQF, with a corresponding assessment policy (DoE, 1998). At this organisational level of the education system, the pedagogical concepts that drive the assessment practices encompass the band specific interpretations of the OBE philosophy and the NQF principles discussed earlier. C2005 was revised in 2000 and the revision resulted in the Revised National Curriculum Statements (RNCS) Grades R – 9 (Schools) (DoE, 2002b). Although the documents analysed in the previous section are being complemented by the RNCS it must be remembered that the new document, the RNCS, is seen as strengthening the policy statements (DoE, 2002a, p.6) and not replacing them. The documents that were printed before the RNCS will still be part of legislation until 2007 (DoE, 2002b, p.3) after which the RNCS will be considered policy.
The following list summarises the documents used to determine the pedagogical concepts that will affect the assessment practices of teachers in the senior phase of the GET band.

2. *Assessment Policy in the General Education and Training Band, Grades R to Grade 9* (DoE, 1998).
5. *Assessment in Outcomes Based Education: Introductory Module.* (ECDoE, 2000b).

In both the C2005 Policy (DoE, 1997a) and the RNCS (DoE, 2002b) the learning outcomes were designed down from the critical and developmental outcomes laid down by the NQF. The critical and developmental outcomes are a list of outcomes derived from the South African Constitution and contained in the SAQA Act (1995c). They describe the kind of citizen the education and training system should aim to create (DoE, 2002b, p.10). The outcomes of the NQF are listed in Appendix A-1. Teachers will be responsible for the development of Learning Programmes which will stipulate the concepts, skills and values on a grade-to-grade basis as well as the scope of learning and assessment activities per phase (DoE, 2002b, p.15). The first time the outcomes are operationalised will be when tasks are written by individual classroom teachers, to enable learners to demonstrate achievement of the outcomes.

C2005 requires a radical rethink on the issue of assessment. The primary purpose of assessment is to assist learners to advance in the required outcomes. Assessment is seen largely as a diagnostic tool, which informs the learner and the teacher about the learner’s progress, gives the teacher information about which teaching methodologies are successful and gives the teacher information about what additional interventions are required (ECDoE, 2000b, p.26). Assessment is not so much about ranking as it is about assisting the learning process (ECDoE, 2000b, p.28).
The new curriculum focuses more closely on the inter-relationship of curriculum, pedagogy and assessment (DoE, 1998, p.9). A strong emphasis is now on integrating assessment and instruction (“seamless assessment” as discussed in Chapter 2); on assessing the process rather than just products; and on evaluating each learner’s starting point. This is emphasised by the Assessment Policy (1998, p.9). The focus of assessment in C2005 should be the clear definition of what learners are to learn: the use of multiple teaching and learning strategies to accommodate individual learners' needs and the use of multiple assessment tools as stated in the Assessment Policy. The changes involve an increasing accountability from the teacher since the role and status of the more routine classroom assessments of the teachers have been enhanced. A culture of learning needs to be created for assessment to be used as part of the learning process. In a culture of learning, learners and teachers would have a shared expectation, a realisation that meaning-making is a joint and worthwhile effort essential for taking the next step in learning (Tamir, 1994, p.95). The ECDoe (2000b, p.27) emphasises the importance of communicating the purpose and assessment strategy to the learners.

Assessment in C2005 should take place with growth and development of all learners (DoE, 1997a, p.33; DoE, 1998, p. 9) as the aim. This is in line with the international trend that assessment should support learning as discussed in Chapter 2. Teachers should balance formative and summative assessment where formative assessment is seen as happening during teaching and learning and summative assessment after teaching and learning. C2005 calls for a much broader range of assessments than has traditionally been used (DoE, 1997a, p.13; DoE, 1998, p.9). The C2005 framework stipulates that assessment tasks should be assessed “throughout the learning process” (DoE, 1997a, p.13) and by means of “continuous assessment” (DoE, 1997a, p.33). The national DoE considers Continuous Assessment as the “best model to assess outcomes of learning throughout the system and to enable improvements to be made in the learning and teaching process” (DoE, 1998, p.9). This view is consistent with the international view as discussed in the review of the literature. Internationally, continuous assessment is seen as the frequency of assessment while the aspect that
determines whether or not assessment is diagnostic, formative or summative is how the assessment data is used (Pahad, 1999).

Again, there is mention of criterion-referenced assessment (DoE, 1997a, p.33). The assessment criteria are "statements of the sort of evidence that teachers need to look for in order to decide whether a specific outcome has been achieved" (DoE, 1997a, p.13). The assessment criteria provide a framework for assessment in the GET band (DoE, 1997a, p.14). The assessment criteria provide evidence that the learner has achieved the specific outcome. They indicate the observable processes and product of learning which serve as culminating demonstrations of learner’s achievement. The implication for the teacher is that he needs to be a subject specialist (competent and confident) in order to make decisions about the most appropriate content, processes, learning strategy and assessment method for effective achievement of the outcome. The teachers should ensure a balance between knowledge, skills and development of values and therefore would need a strong content knowledge base from which to make decisions.

A further concept is that the curriculum is results-orientated. Learning progress is based on “demonstrated achievement” of the outcomes (ECDoE, 1999, p.9). The curriculum calls for emphasis on the assessment of learner performance rather than a narrow focus on knowledge (DoE, 1998, p.9). It is expected of teachers to devise a comprehensive assessment strategy to assess learners as they perform tasks. The teachers have to adapt the specific outcomes in various contexts but also develop similar tasks to allow for multiple opportunities for the learners to demonstrate their achievement of the outcomes. It is also implied that teachers should possess the competence to recognise and clearly describe the developmental progress levels associated with the skills in the different contexts. The C2005 policy document also refers to the flexibility in the choice of specific content and process to best achieve the specific outcomes (DoE, 1997a, p.19). This leads to the idea of using a learner-centred approach to assessment.

The Eastern Cape DoE’s Training document encourages learners to participate actively in their own assessment through self- and peer assessment or participate

5.5 **ASSESSMENT IN THE SENIOR PHASE OF THE NATURAL SCIENCES LEARNING AREA**

The focus of this study is the science assessment competences expected of teachers in the senior phase. In order to be in line with the new developments, the South African science teacher will need newer and more relevant assessment techniques, and will need to utilise current techniques in ways that are more creative. The question arises: What do educators need for assessing science in the senior phase? The content pedagogical concepts that drive the assessment in the Natural Sciences learning programme will be elaborated from the following national and provincial documents:


The formation of this learning area represents a fundamental change to what was taught in the past (ECDoE, 2000a, p.5). With the introduction of the new curriculum, changes in the approach to teaching science were introduced with the focus on the achievement of knowledge, skills, values and attitudes as part of the outcomes based approach that was adopted. The entire philosophy which underpins the Natural Sciences Learning Area, changed to one of “science for all”, “science for life” and “science in service of society”. This is in contrast with the previous philosophy of “science for science’s sake” (ECDoE, 2000a, p.5) but in line with an international trend of science reform aimed to provide some science and technology for all learners.

The rationale for the Natural Sciences learning area as stated in the C2005 Policy illustrates the change in focus.

*The Natural Sciences, comprising the physical, life and earth sciences, involve the systematic study of the material universe - including natural and human-made*
environments - as a set of related systems. A variety of methods, that have in common the collection, analysis and critical evaluation of data, are used to develop scientific knowledge. Learners need to know that Science is a human activity, dependent on assumptions, which change over time and over different social settings (DoE, 1997a, NS p.5).

Firstly, the domain of the learning area is a combination of themes with the introduction of earth sciences not traditionally taught by the science teachers. Consequently, the nature of the content is different from that of the past. The conceptualisation of the learning area will be discussed later in more detail. Secondly, the view of how science should be learnt has changed, with the current emphasis on the development of scientific knowledge through active participation of the learners in the learning and assessment process (DoE, 2002a, p.30). The fact that learners will have to do projects and investigations while they construct their own scientific knowledge is made clear in this extract. In view of this, the new learning area represents a significant change from the traditional narrow, mechanistic, fact-accumulation curriculum towards a broad and balanced curriculum for all learners, which in the words of the RNCS should be “a meaningful science education” (DoE, 2002c, p.5). Meaningful science education is learning-centred, helps understanding of science knowledge and its production and helps to understand the contextual environmental and global issues intertwined in the learning area as reflected in the above rationale.

The purpose of the Natural Sciences learning area is to foster scientific literacy (DoE, 2002c, p.4), which is in line with the international trend for science education as identified in Chapter 2. The Learning Area sets out to achieve this purpose through:

- The development and use of science process skills in a variety of settings;
- The development and application of scientific knowledge and understanding; and
- The appreciation of the relationships and responsibilities between science, society and the environment (DoE, 2002c, p.4).

A defining characteristic in the Natural Science learning area is the practical application of knowledge in the daily lives of the learners (DoE, 1997a, NS p.4; DoE, 2002c, p.4) and the integration and application of knowledge and skills (DoE,
The pedagogical implication of this characteristic is summarised by the excerpt from the C2005 Policy statements (DoE, 1997a, NS p.11):

Theoretical knowledge is necessary but not sufficient. The ability to apply knowledge is essential. It is through the ability to use, extend and apply knowledge that a learner can be said to “understand” concepts and principles in the Natural Sciences.

To conceptualise the new curriculum the Natural Sciences learning area was established around four themes (Energy and Change; Life and Living; Matter and Material: Earth and Beyond) in order to provide the context needed for the demonstration of the specific learning outcomes in the Natural Sciences learning area (DoE, 1997a, NS p.3). The themes represent key organising concepts or essential elements that pervade science education. Each theme is expected to “provide a context which can be used to assess learning” (DoE, 1997a, NS p.3). These fields of inquiry need different data and use different methods of investigation (DoE, 2002c, p.5). The Learning Programmes must draw content from all four strands over a Phase and by the end of Grade 9, every learner should be able to interpret and to apply these concepts in both familiar and somewhat unfamiliar situations. 30% of the time in a senior phase Learning Programme should represent local options or contexts that are significant to the learners and the local community (DoE, 2002c, p.61). The development of these Learning Programmes is the responsibility of the classroom teacher.

In the National Statement on the Natural Science learning area (DoE, 1997a) the national DoE highlights the integrated nature of the Learning Area and emphasises that...

...an integral part of this perspective is the need for practical activities and skills. Knowledge cannot be divorced from the practical skills involved in acquiring and using this knowledge. In the same way, attitudes and values of learners – developed and used when working in science contexts – are an important part in the conceptualisation of the Natural Sciences (DoE, 1997a, NS p.7).

The conceptualisation of the Natural Sciences learning area includes three aspects, namely, scientific knowledge, the skills needed for the application of the knowledge and the appropriate dispositions (guided by attitudes and values) for
working in the science contexts identified by the themes. The approach to science education is described as a practical, investigative approach to the acquisition of knowledge in the Natural Sciences, illustrated by the statement in the C2005 Policy (1997a, NS p.5):

*The investigative character of knowledge acquisition in the Natural Sciences should be mirrored in education. Learners should be active participants in the learning process in order to build a meaningful understanding of concepts, which they can apply in their lives.*

The emphasis on the use of practical activities and skills in acquiring and using knowledge (DoE, 1997a, NS pp.6,7) becomes clear from the extract above. This focus on the use of a practical approach is consolidated with the statement in the C2005 Natural Sciences Policy:

*Experimental work is a defining characteristic of the Natural Sciences...practical work should involve active pupil participation (DoE, 1997a, NS p.4)....and an integral part of [this] perspective is the need for practical activities and skills (DoE, 1997a, NS p.6).*

This viewpoint is elaborated on by the Eastern Cape DoE (2000a, p.15) that broadens the concept of practical work to include activities such as project work, library research, fieldwork, site visits, environmental monitoring and investigations. This focus by the national DoE on practical work is considered to be a mode of learning on its own and must be treated as such since the “*process of investigation*” is central in Natural Sciences (DoE, 1997a, NS p.9). Problems have to be solved and decisions made (DoE, 1997a, NS p.13) when learning is assessed. As discussed in Chapter 2, the different types of practical activities (such as practical experiences, single-skilled practical exercises and problem based investigations) emphasise different process skills and are appropriate for different types of learning. A variety of these should consequently be included to ensure valid assessment. The Eastern Cape DoE promotes a shift from keeping practical work simply “hands-on” to including some “minds-on” practical work by:

- Linking theory and practical sessions;
- Letting learners perform open ended investigations;
- Linking practical work to real-life experience;
- Linking instructions to purposes;
- Encouraging learners to make and test predictions; and

- Letting learners write their own instructions (ECDoE, 2000a, p.20).

Consequently, the senior phase learners should be assessed on their ability to progressively think through more problems that are complex without actually doing those (DoE, 2002c, p.45) and should be provided with tasks that elicit this type of thinking.

As mentioned earlier, the C2005 Policy indicates that active learning participation should form, with practical activities and skills, an integral part of the conceptualisation in the Natural Science learning area (DoE, 1997a, NS p.5). It can consequently be deduced that the aim of active pupil participation in the learning activities should be to conceptualise the learning material.

_The ability to apply knowledge is essential. It is through the ability to use, extend and apply knowledge that a learner can be said to “understand” concepts and principles in the Natural Sciences (DoE, 1997a, NS p.11)._ 

Thus, the learning of science should be authentic and connected to the world outside of the classroom in order to develop the ability to use the knowledge acquired in real-world settings. In addition to the development of cognitive abilities, classroom expectations should foster the development of important dispositions, such as willingness to persist in trying to solve difficult problems (Shepard 2000, p.7).

In summary, the Natural Sciences learning area deals with the promotion of scientific literacy through the development and the assessment of process skills in a variety of settings; scientific knowledge and understanding; and an appreciation of the relationships and responsibility between science, society and the environment (DoE, 2002c, p.4). Consequently, the assessment in this Learning area is

_...a continuous, planned process of gathering information about the performance of learners. It requires clearly-defined criteria and a variety of appropriate strategies to enable teachers to give constructive feedback to learners (DoE, 2002c, p.77)._
In conclusion, in the analysis of the documents related to the assessment practices of the science teachers in the senior phase of the GET, two main concepts emerged and need to be accentuated. The first is “integrated assessment” and the second is “credible assessment”.

The principle of integrated assessment in NQF documentation focuses on an integration of the knowledge base of a discipline (the knowledge, skills, attitudes and values particular to the discipline) through the application of the knowledge base in a variety of relevant contexts. Another angle to the principle addressed in the documents is the aspect of integrating the different purposes of assessment (diagnostic, formative and summative) on a continuous basis throughout the learning experiences. The implications of integrating the knowledge base and the types of assessment are numerous since they touch on the whole educational culture in the classroom. Three aspects important for the context of this research are listed below.

• An integrated demonstration of the achievement by the learner will need to be assessed in a variety of contexts, which implies the sources of the evidence will be varied. This creates the need to make use of a variety of assessment approaches, methods and techniques.

• The teachers and the learners will need a clear, unambiguous picture of the product as well as the process that will lead to the product, in order to provide integrated assessment. This will result in assessment being used as a tool to facilitate the achievement of the product and assessment used for learning.

• This will eventually result in a close relationship between the curriculum, that is, the learning outcomes, the pedagogy in the classroom and the assessment. This concept of “seamless” teaching, learning and assessment is discussed in Chapter 2.

The notion of “integration” is also evident in the Natural Sciences learning area. Firstly, it is reflected in the nature of the learning area where four themes from different disciplines in the Sciences are integrated to form the newly constituted Natural Sciences learning area. In the second place, the notion is addressed by the
concept of “meaningful science” which symbolise the integration of the knowledge base of the Sciences into the contexts of the environment and socio-economic issues (DoE, 1997a, NS p.5). The implication for the pedagogy is the practical application of scientific knowledge in the daily lives of the learners (DoE, 1997a, NS p.4). In order to achieve this vision, the focus should be on the integration of the knowledge base as emphasised by the NQF in the earlier discussion.

The Natural Sciences learning area lastly addresses integrated assessment by advocating a teaching-learning approach in which the focus of all the classroom activities will be towards the active participation of all learners. Together with practical activities and skills, this will form an integral part of the conceptualisation in the Natural Sciences learning area (DoE, 1997a, NS p.5).

A concept of “credible assessment” is a central theme throughout the different educational “layers of influence” as identified in paragraph 5.1. SAQA highlights the importance of a credible assessment system as the foundation for the fair, reliable and valid assessment of learners and their achievement (SAQA, 2000a, p.5). Legitimacy and credibility in assessment can be ensured through assessment procedures and practices that are governed by the principles of fairness, validity, reliability and practicability (SAQA, 1999a, p.7). The implications are that assessment should be transparent, clear and available to all in order to be fair; the assessment methods and instruments used should allow appropriate and sufficient evidence to be collected to be valid; the outcomes and the assessment criteria should be the basis for the assessment process to be reliable; and the assessment planned should be feasible, given the educational context of the teachers and the learners.

C2005 documents addressed the issue of credible assessment through individual aspects that were emphasised in both the general and the Natural Sciences learning area documents. Considered together they will contribute to a credible assessment system. The individual aspects include criterion-referenced assessment to ensure reliability; fair assessment that ensures reliable and valid assessment information; continuous assessment to ensure that sufficient evidence
is collected to be valid; and the planning of the assessment process to ensure that the principles for credible assessment of the NQF are implemented.

The policy makers’ expectations regarding the assessment competences of science teachers have been illuminated in this chapter. The actual assessment practices of three participant teachers were described in Chapter 4 in order to provide the context in which the expectations of the policy makers should be interpreted in Chapter 6. This will culminate in the establishment of a need for the development of an instrument that could be used by teachers to determine their own competence in the assessment of science in the senior phase of the GET band on the NQF, with the view of their attending an appropriate training programme.
Chapter Six
Analysis and Conclusion

6.1 INTRODUCTION

Having sketched the learning environment and the assessment practices of 3 teachers, the study moved to the expectations of the education department. The document analysis focused on the competences required from science teachers in the Senior Phase. In order to answer the third sub-question teachers’ practices need to be compared to the competences expected of those teachers. This analysis will cover the observed lessons, the interviews with the teachers and the assessment related artefacts produced by the teachers and the learners. Details on the principles guiding effective classroom-based assessment practices provided by the literature review and the analysis of the South African documents, as well as the transcriptions of the interviews, the classroom observation and the artefacts, form the foundation of this analysis.

I made use of an inductive approach to the analysis, which means that categories, themes and patterns came from empirical evidence. The categories emerged from the literature review, the field notes, documents and interviews and were not imposed before the empirical material collection (Janesick, 1998, p.47). I worked from the particular to the more general perspectives of themes and categories.

The case studies of each school provide the basis for cross-site comparisons making use of the comparative analysis technique (McMillan & Schumacher, 1997, p.470), with the focus on the description of assessment practices in a selection of South African schools. The unit of analysis is what Tellis (1997, p.5) calls a system of action, namely the science assessment activities of the teachers. Several pieces of information from the same case were related to some theoretical proposition that lead to conclusions (Tellis, 1997, pp.6,9). I created “layers of analysis” (Cresswell, 1998, p.77) by extracting numerous themes from the observations, interviews and artefacts. The grouping of these themes flows into broader and more abstract categories. The substantive focus and intent to infer the assessment competences
expected of the science teachers kept the analysis qualitative (Erickson, in Janesick, 1998, p.44).

By making use of “categorising,” which is attending to similarities among various different pieces of data, as well as “contextualising the data”, where one attends to the ways in which the various pieces of data fit together, the data is easier to understand. The joint use of these two data analysis approaches serve as a further form of triangulation.

During the data interpretation, I compared patterns of assessment practices in terms of those identified in the documents, with the empirical patterns as they emerged from the empirical data (Tellis, 1997, p.9).

6.2 ANALYSIS OF PRACTICE
McMillan (2001, p.17) identified two major sources of influence that affect assessment practices. One source consists of external pressures on classroom practices. These pressures are external factors that will have an influence on the practices of teachers, such as the new South African Educational System. Such expectations were discussed in Chapter 5. The second source consists of the beliefs and values held by teachers about teaching and learning in general but specifically those of science. This philosophical base explains how specific assessment practices are used since the assessment practices will be consistent with the teachers’ philosophy of teaching and learning.

6.2.1 The need for a change in philosophical base
The general mindset expected from the teachers in C2005 changed from a testing paradigm to that of establishing a culture of learning in classrooms. The use of isolated assessments, where a single test is seen as a measure of student learning, changed to one of multidimensional assessments integrated into the classroom instructional process. Accompanying this general assessment philosophy, the Natural Sciences learning area was established with an emphasis on a “science for all”, “science for life” and “science in the service of society” philosophy (ECDoE, 2000a). This is in contrast with the previous philosophy of
“science for science’s sake”. The emphasis shifts to a learning orientated approach to teaching and learning science and has had an influence on the expected assessment practices of the teachers in the classrooms.

The traditional training received by teachers reinforced the philosophy that science is done for its own sake. Annette’s vast experience and training in science-specific major subjects in her BSc Honours degree, sometimes made it difficult for her to adopt a “softer” approach to the learning of science. Fortunately, this was balanced by her vast educational experience. It gave her the courage to adapt to new approaches and the ability to reflect upon new approaches and philosophy in education.

A You know, you start getting direction. Yes, but there is still a lot of work to do. ...It is not a thing that would become clear at once...I do not know what people without experience do. Those that do not have enough knowledge.

It is evident that Annette sometimes falls back on the philosophy of science for science’s sake. Seen against the background of her formal training she received in her major subjects, it is something to be expected.

A With the electricity I find that they start fiddling around with the apparatus. They will make their own connections and so on. But the classes are too big and the time does not allow this. You sit with about 33 learners in a class...Some of the things in the old syllabus we repeat because we know it and we also know the learners will need it.

This reflects the tension between the traditional training and experience that is deep-seated and the willingness and professionalism to adapt and to try new things because one feels confident using one’s own background knowledge.

With regard to Michael, the tension was not a result of the subject training he received, but rather due to the lack of it. He did not have the content knowledge or knowledge about the nature of the physical sciences that could have provided him with the necessary base on which he could rely when he was expected to adjust his classroom practice. It was possible for him to adopt the “softer” approach to
teaching and to assessing science because the softer approach provided him with a mechanism to cope with the shortage of physical science training and experience. This was evident from the narrow focus of his teaching and his assessment practice and the lack of “doing science” as established in Chapter 2. He focused heavily on the establishment and the development of values and attitudes, but, unfortunately, he applied this as life-orientation and did not emphasise science contexts. He values active learner participation in the classroom, which is evident through his regular use of self-assessment, peer assessment and class assessment. There are also regular negotiations taking place in the classroom. The classroom culture is a free discussion and participation culture (see Chapter 4 for detailed descriptions), but the progression in science from the knowledge of science to the applying of the knowledge in investigations (see Figure 2.3) did not occur.

Although Grace received further training in Science and Technology (see Chapter 4 for details), she did not make the new philosophy of the Natural Sciences learning area part of her belief system. She made physical changes to the classroom, made use of permanent group settings and planning documents indicate an attempt to plan according to the guidelines given during the training. However, neither the teaching practices nor the assessment practices reflect a change in philosophy. There is tension between a belief that the correct answer implies understanding, and that assessment should not offend but encourage learners. In her words: “Give him the mark that is going to encourage him”.

Although she felt that feedback should rather encourage learners than indicate the things that are wrong, this happened at the expense of the learners’ development towards the achievement of the goals of scientific literacy (see Chapter 2).

What is missing from all three teachers is a change to their personal philosophical frameworks that reflects the philosophy of the Natural Sciences learning area. They do things to comply with the departmental policies without taking ownership of the process. Critical and independent thinking processes sought after by the NQF through the critical outcomes (see Appendix A) are not incorporated and
emphasised in any of these classrooms. This indicates a tension between the personal and the external education system requirements as illustrated by Figure 6.1.

![Diagram](image)

Figure 6.1 An illustration of the factors influencing teacher assessment practices.

The first area in need of professional development has been identified as the philosophical base of the teachers. Addressing their beliefs and values regarding the teaching of science will reduce the tension that exists between their beliefs and the external pressure provided by the South African educational system. This will result in correlation between teaching and the assessment of the resultant learning.

Annette’s classroom-based practices revealed a lack of correlation between teaching and assessment. Although the assessments reflect something of the new philosophy, her teaching practice and consequently formative assessment during the learning experiences did not reflect it. The teaching was textbook driven with evidence of a strong belief in the intrinsic value of science through her following the workbook and not allowing learners to explore the electrical equipment because of insufficient time.
A With the electricity I found that they started fiddling around with the apparatus. They started to make their own connections and so on. But the classes are too big and the time does not allow this.

Annette did not take ownership of the changed philosophy behind the Natural Science learning area. This resulted in her dedication to externally developed workbooks instead of her own unique learning programme that suits her learners and her individual teaching style. The narrow focus of textbook driven teaching is a result of this lack of ownership.

In conclusion, it is evident that the philosophical bases of the teachers did not change from what they believed in the past. They would need professional development to change their beliefs. Recommendations regarding professional development aimed at enabling a change in teachers’ philosophical base will be addressed later in this chapter.

6.2.2 The need for subject knowledge

Teachers should be competence to function in all the domains and on all the levels of development as illustrated by figure 2.3 and expected from the learners. Then only will they be able to assess the learners’ products and processes competently. The three teachers each displayed a different level of competence in using their knowledge of science.

Although Annette has a strong knowledge of the Physical Sciences, she lacks an understanding of the knowledge underpinning the “Earth and Beyond” and the “Life and Living” themes of the Natural Sciences learning area. During an interview, Annette mentioned she is not confident in helping learners with aspects related to Biology. This will adversely affect the integrated nature of the Natural Sciences learning area, where the focus is on the interrelatedness of the four themes of the learning area. In order to address the phenomenon of specialisation by secondary school teachers, Annette’s school implemented a team-teaching approach for the teaching of the learning area. Each member of the team would be considered an expert and competent enough in the aspect of the knowledge to succeed in the implementation of the learning programme. On the positive side, the learners
would benefit from a specialist who is confident and who is capable of facilitating
the meaning-making processes in the classroom. Annette explains:

A Last year we allocated Grade 8 Natural Science to one of the three teachers, but since he was only qualified in one of the three areas, he rushed through the areas that he did not know and was also very anxious about those sections.

A This year we decided to split the learning area between the three speciality areas. We have three teachers for the learning area, the Geography, Biology and pure science teachers. The specialists, who complement each other, therefore teach the different themes.

This approach is not without problems. On the negative side the integrated nature of the learning area and the philosophy behind the teaching and assessment practices were sacrificed. Again, Annette commented:

We just combine the final marks; we do not provide them with integrated tasks. Each teacher sticks to his/her area.

Annette’s strength in Physical Science is in contrast with Michael who is stronger in Geography and Biology, but lacks confidence in Physical Science. Michael’s lack of confidence in these sections is shown by the statements he made during an interview pertaining to the teaching method he used for the units on “Magnets”, “Acids and Bases” and “Energy”. Michael indicated that these units were taught more “formally” (meaning that no groupwork was done) by implementing the lecture method, since “Magnets are abstract information that need to be taught. It [magnets] cannot be discovered by the learners”. The same argument was used for the units on “Acids and Bases” and “Energy”. Michael needs to be shown during professional development opportunities how to make these sections more practical.

Grace is in need of training that would cover all four themes of the learning area as evident by the discussion to follow. Grace’s own lack of conceptual understanding is illustrated by the next explanation she provided for the learners.

G: “A good conductor of heat keeps the heat. A bad or poor conductor of heat loses the heat. Remember, energy can only change from one form to another. You cannot destroy energy. Think of the kitchen. If you light the stove, the whole kitchen is warm. Energy is transferred from one form to another. The blankets make us warm after a while. Energy is transferred or
transformed. It cannot be destroyed. What else do you have at home that are good conductors of heat?"
L5: “Stainless Steel.”
G: “What is the colour of the Stainless Steel?”
L5: “Silver.”
G: “Yes! Silver is a good conductor of heat. What else?”
L6: “Frying pan.”
G: “I want the material. What else?”
L7: “Knife made of steel.”
G: “Iron, silver, metal, copper, brass, they are all good conductors of heat.”

Firstly, she confused the concepts of good and bad conductors of heat as indicated by the explanation that “good conductors keep the heat”. Secondly, she addressed the concepts of transference of energy from one object to another and energy that is transformed from one form to another form without helping learners to create a concept of each aspect. Lastly, she named a few examples of good conductors of heat and included the concept of metal as part of a list of types of metals instead of the list of good conductors of heat. Such imprecise explanations do not contribute to the meaning-making process that should be taking place in the classroom if the learning target is the application of conceptual knowledge in a variety of contexts.

Another phenomenon illustrating Grace’s lack of conceptualising the knowledge domain of the Natural Science learning area is the practice of guiding learners through the use of questions to guess the “correct” answers that she has in mind already. The question and answer series below illustrates the guiding of learners to the “correct” answer (as conceived by Grace) and the resultant lack of providing an opportunity for learners to progress towards the development of conceptual knowledge.

G: “We get good conductors of heat. Can you give me a material that is a good conductor of heat?”
L4: “Stove.”
G: “What is the stove made of?”
L4: “Stainless Steel”
G: “What is the material of the plate made up of?”
L4: “Iron.”
G: “Very good. So, the iron is a good conductor of heat.”

It is clear that Grace would not accept any other answer except the one that she eventually received. This “guessing strategy” used by the learners was reinforced
by the positive feedback given upon guessing the correct answer. The teaching technique was not used to facilitate the learners’ conceptual understanding of a good conductor. Grace resultantly needs to build her own conceptual knowledge before she would be able to effectively assess the learners’ conceptual knowledge.

It is evident that teachers need subject knowledge if they are to implement integrated assessment as part of their assessment practise. It is further evident that subject knowledge on its own is not a guarantee that the assessment practices will reflect the full spectrum of the Natural Sciences learning outcomes as indicated in Appendix A.2. The subject knowledge of teachers should be accompanied by a change in the philosophical base of teachers.

6.2.3 Assessment practices

Since the change of the philosophical base of an education system should culminate in a change in the assessment practices in the classroom, the focus of the analysis moves to a correlation between the assessment practices and the expectations of the education system. What follows is an interpretation of the expectations (as described in Chapter 5) in current assessment practices of teachers observed (as described in Chapter 4) in order to establish individual teacher’s needs for professional development.

From documents analysed in Chapter 5, two broad aspects, namely, integrated assessment and credible assessment, were chosen to represent the expectations of the national DoE. I acknowledge that more aspects could be discussed, but these aspects could be considered as being overarching to being competent in assessing science in the senior phase of the GET band. Under the concept integrated assessment, the focus could be on the type of teaching practices and resultant assessment practices that are expected and eventually implemented. The flipside of the coin could be to focus on the quality of the practices as addressed through the provision of credible teaching and assessment.

In reality, each teacher functions within different circumstances and brought to the fore very different personal qualities. Table 6.1 summarises the strengths,
weaknesses, opportunities and threats that influenced effective assessment practices of each of the three teacher’s situations, based on the descriptions in Chapter 4.

The aim of this analysis is to establish any patterns in assessment practices regarding the two broad aspects chosen. These classroom practices and assessment practices will be discussed in relation to the two aspects chosen, with the view to establishing the need for professional development.

Table 6.1 The strengths, weaknesses, opportunities and threats influencing effective assessment practices.

<table>
<thead>
<tr>
<th></th>
<th>Michael</th>
<th>Grace</th>
<th>Annette</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td>Focuses on the development of values.</td>
<td>Open to change.</td>
<td>Subject content knowledge.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Integrates Knowledge, Skills and Attitudes in written examinations.</td>
</tr>
<tr>
<td><strong>Weaknesses</strong></td>
<td>Classroom management. No real focus on science.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of Personal conceptual development.</td>
<td></td>
<td>Teacher-centred approach to teaching.</td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td>Brings real life into classroom.</td>
<td>Does practical work in her classroom.</td>
<td>Uses her experience to adapt traditional tests to a means of alternative assessment.</td>
</tr>
</tbody>
</table>
6.3 INTEGRATED ASSESSMENT

The principle of integrated assessment as adopted by the NQF (SAQA, 1999a) and discussed in Chapter 5, acts as an overarching concept to illustrate the expected assessment practices and procedures of the teachers in the new curriculum. It can also be related to the international trend in classroom assessment that focuses on assessment as a tool for learning, as mentioned in Chapter 2.

Integrated assessment requires learners to demonstrate applied competence. Applied competence is the amalgamation of the knowledge base for the Natural Sciences learning area illuminated in Chapter 2 and represented in Figure 2.3. This includes factual knowledge, practical knowledge, conceptual and procedural understanding of the learning and application thereof when doing investigations. These investigations are situated in a variety of social, economic and environmental contexts and across the four themes of the learning area (DoE, 2002b, p.4). There is a natural progression from gaining factual and practical knowledge to integration of concepts and procedures when doing investigations. The implication is that the content of the assessment tasks given by the three teachers should reflect the full spectrum of learning in science.

If knowledge, skills, attitudes and values are to be integrated when assessing, then how assessment is done becomes important. In order to enable learners to demonstrate applied competence, they should be provided with opportunities to develop their knowledge base in the four themes of the Natural Sciences learning area.

A complete picture of the applied competence of learners can only be achieved if different assessment approaches are used to gather information on what they can do and what they understand. Chapter 2 established that effective assessment requires teachers to collect and to synthesise as much accurate information from as many sources as possible. They should integrate the data from informal observations and interactions with the more formal measurements obtained.
Teachers need to understand and use the entire range of assessment techniques and methods with the realisation that each has limitations (McMillan, 2000, p.5).

6.3.1 Integrating knowledge, skills, attitudes and values

Grace and Michael did not integrate work completed with other tasks set later in the year that could have resulted in learners using the knowledge and understanding they had gained earlier. The result is fragmented, atomistic chunks of information so that the integrated nature of the Natural Sciences learning area, documented as imperative by the DoE, is absent. Evidence from Annette’s practices indicated that she also did not integrate certain sections in the Natural Sciences learning area. They divided the learning area in fragmented, divorced sections and in the process lost the integrated nature of the learning area.

I found a commonality between the practices of the two primary school teachers (Grace and Michael) regarding the integration of the knowledge base of science. Both primary school teachers received the same general training in different domains of the Natural Sciences learning area. When Grace’s and Michaels’s tests were analysed, the following common practices were found in both.

Firstly, the data collected from Grace and Michael’s assessment practices indicated a strong focus on the assessment of factual knowledge with very little attention given to the development of practical knowledge. The cognitive complexity of their tests does not go beyond the factual knowledge level. Very little attention was given to assess higher levels of understanding and complex thinking. Examples of Michael’s and Grace’s tests can be seen in Appendices B and C. Grace’s Biology test for Grade 7 illustrates the narrow focus of questions asked in the tests:

1. Complete the following.
   a) The vertebrate class which swims with the fins is the ...........
   b) What does a fish use to breath?
   c) The body of a fish is divided into three parts - name them.
Memorandum for the Biology test.

1.a) Fish
2.b) gills
3.c) Head, trunk, tail.

Secondly, the assessment of practical knowledge and skills was done in a similar manner. Practical knowledge includes both thinking skills and practical skills. Michael indicated that he made use of a practical test for the learning unit on Measurement. The only practical aspect of the test was the identification of the measurement devices they had discussed in the classroom, as well as a phrase describing the particular use of each of the instruments. He had a drawing of each instrument and learners had to write the answers on the question paper. The factual knowledge regarding the apparatus was tested, but no practical application or use of knowledge in a variety of contexts was part of the assessment. Likewise, no evidence could be found of assessment of progression from application of knowledge to the development of conceptual understanding and procedural understanding to the doing of science.

In contrast, Annette attempted to address the assessment of factual knowledge and practical knowledge as well as touching on the assessment of conceptual understanding.

Lacking in Annette’s practices are the development of procedural understanding and doing open-ended investigations. No assessment of attitudes specifically associated with scientific literacy happened. A gap exists between the theoretical principle of integrated assessment and the actual assessments of teachers in the classrooms. They should integrate the data from informal observations and interactions with the more formal measurements obtained. Michael did this in his groupwork assessments. The teacher needs to provide the learner with opportunities to firstly develop each of these aspects in slightly fragmented contexts to develop confidence and competence in the individual aspects. Thereafter, the learning and assessment tasks should focus on conceptualising the knowledge and using it with the procedural understanding to do investigations.

Before the progression and achievement can be assessed, a well-orchestrated
plan needs to be developed to ensure that the whole progressive development framework illustrating the knowledge base of the sciences is addressed.

6.3.2 Balanced use of diagnostic, formative and summative assessment

The focus on the achievement of outcomes in the Natural Sciences learning area, will lead to a phenomenon identified as “seamless” teaching, learning and assessment (Nitko, 2001, p.148) in which classroom-based assessment practices are embedded in the curriculum. Consequently, the emphasis of assessment is on both the process of learning and the product of learning against performance criteria that illustrate the achievement of the learning outcomes. This reflects the international focus on the use of assessment as a tool for learning through continuous use of formative and summative assessment as discussed in Chapter 2 (see paragraph 2.3).

Evidence of the presence and the use of the types of assessment by the teachers are varied and complex with each teacher displaying a unique combination of practices. Annette developed a well-structured summative assessment system in which her learners are provided with ample opportunities for summative assessment. She builds the application of knowledge through the year with summative assessment opportunities, until a culmination of the year’s learning is assessed in November examinations. The focus of Annette’s assessment practices falls heavily on the written summative assessment of conceptual understanding.

Annette diagnosed a need to develop responsibility towards homework completion and planned a more structured, planned formative assessment strategy. In the second semester, it culminated in summative assessment when their homework contributed towards the final assessment mark. A less structured example of an interactive formative assessment (as discussed in Chapter 2, paragraph 2.3.2) comes from the focus on the use of language in Annette’s class.

A I constantly talk about statements in my class, about language. If they write things for me in a test, I would point out the incorrect use of language. You would make them aware of the use of language.
Although there is evidence of the use of diagnostic, formative and summative assessment in Annette’s classroom practices, the formative and consequently the diagnostic aspect of the others are still in the developmental phase. In order to ensure seamless teaching, learning and assessment, Annette would need a training module on the effective use of formative assessment in a science classroom.

When comparing Michael’s practices with Annette’s the contrast, in terms of structure and planning for summative assessment, is evident. In Michael’s class summative opportunities existed after the completion of a selection of learning units (or “chapters”). No examinations are written except for a final November examination is written. There is thus only one final opportunity for the learners to demonstrate their competence in applying the knowledge, skills and attitudes they have achieved during the year. The learning units received a holistic impression mark when they were completed. The focus of these units is not on the integration, but rather on completion of the work. Tests combined two or three learning units’ knowledge and tasks such as oral presentations, complement the above information.

The implementation of formative assessment in Michael’s class is geared towards the social and the attitudinal aspects of learning, such as the value of being on time and for apologizing if you miss a class. Attributes associated with science-specific actions are not addressed. Feedback is not clear and criterion-referenced. It does not indicate what actions are needed to close the gap between what they do and what is expected. The interactive formative assessment as part of the dialogue in the classroom is directionless. The focus of Michael’s assessment practice is on the formative assessment of general social values and attitudes.

Grace’s summative assessment system is underdeveloped in terms of structure, planning and the use of a variety of question types to elicit information on the full spectrum of learning expected from Grade 7 learners. Although she functioned in a unique educational setting with particular financial limitations to her practice, the optimum use of available resources does not take place. Each of the learners was
in possession of a textbook with questions that could have been used to set tests that focussed more on the integration of thinking skills. The summative assessment opportunities provided, included class tests and two projects for the year.

Formative assessment does not receive sufficient attention allowing it to contribute to the growth of the learners. Grace leads her learners to provide her with the answer she is looking for. This does not encourage thinking outside the known concepts and the feedback provided or lack thereof reinforces this idea. Any formative assessment that takes place in Grace’s classroom can also be considered as directionless. Feedback is a crucial element of formative assessment and is more effective when combined with comments. By marking each learner’s work and then going over the answers, she provided feedback.

The effective use of formative assessment by teachers emerges as a generic area in need of professional development since it is linked to the provision of criterion-referenced and of precise feedback, an area lacking with all three teachers.

In summary, a common aspect of Integrated Assessment is identified in their practice. All three teachers had a lack of diagnostic assessment practice and a lack of a structured, intentional use of formative assessment. Since the use of diagnostic and formative assessment are relatively new introductions to the educational system, it can be deduced that most of the teachers in the Eastern Cape area will lack competency in this area. They would most probably be in need of the same professional development as the three participating teachers. The summative assessment practices revealed a combination of practices with different strengths and weaknesses, which implies a differentiated need for professional development. Although the formative assessment practices could be considered a generic module, the use of summative assessments should not be. The data revealed a variety of needs in this area.

6.3.3 Criterion-referenced assessment

Although performance criteria are at the heart of the successful assessment of applied competence, they are the area in which most problems occur (Airasian, clxxvii
Airasian reports studies (Fager, Plake, Impara) showing that many classroom teachers lack the skills in assessing and are unprepared when it comes to implementing performance assessments on their learners. Teachers’ interpretation and judgement are necessary for scoring learners’ performances and their products. Judgement is subject to many distractions that are not relevant to scoring. The implication is that they are ill-prepared at identifying criteria that describe what constitutes a good task or a good performance.

Michael does not need a course on the types of assessment, but on developing assessment criteria. He made use of written, and oral presentations as well as teacher, self- and peer assessment (see Chapter 4 for details), but the assessment criteria were limited in range and depth. His assessment sources did not provide accurate assessment information regarding the application of knowledge and understanding. Michael does not stick to criteria that he plans. Even during the planning, there is no clear focus on assessment criteria. From the teachers’ practice of giving assessment criteria to learners verbally and not emphasising the recording of the criteria for use later, the impression is that teachers do not feel that assessment criteria are important. Even Michael’s daily classroom talks lack precision, which lead to the criteria not being clear to learners: they do not understand the purpose of the criterion-based assessment.

Annette provided her learners with criteria for her projects, but more emphasis on the transparent communication thereof before the projects started would result in information that is more accurate. She could attend a more advanced module on the designing of assessment tools in order to improve the alternative assessment tasks. Grace is in need of a unique module addressing the constraints posed by her particular educational environment. Given the lack of consumables, she would need training in ways to cope with performance assessments and transparency during the giving of instructions.

One way in which the essential collection of a variety of assessment evidence required by C2005 can take place, is to plan the curriculum and learning programme carefully (Bentley & Watts, 1992, p.145). This aspect will be revisited in clxxxvii
the discussion on credible assessment since criterion-referenced assessment is linked with fair assessment.

6.4 CREDIBLE ASSESSMENT

It is internationally accepted that high-quality teaching and learning is impossible without sound and credible assessment. As mentioned in Chapter 2, internationally, the focus of assessment shifted to the use of assessment results for learning, the consequences of assessment and what the assessments encourage learners to do.

In Chapter 5, the need for credible assessment practices was established (SAQA, 2000a, p.5). Since assessment is viewed by SAQA (1999a, p.6) as “a structured process for gathering evidence and making judgements about an individual’s performance in relation to...[the learning outcome]”, the quality of the assessment is important. Planning and implementing an Integrated Assessment approach is not divorced from the provision of credible assessment. The value of the teachers’ judgements depends largely on the accuracy of the information obtained. According to the NQF, credible assessment is ensured through assessment procedures and practices that are fair, valid, reliable and practical. Although the international trend is to move away from rigid standards of validity and reliability and Swain (2000) warned in Chapter 2 that issues of validity and reliability could be misunderstood, it is still important in the context of the NQF. The credibility of the assessment practices of the three teachers will be considered in terms of fairness, validity and reliability.

6.4.1 Fair assessment

Fair assessment provides all learners an equal opportunity to demonstrate achievement and yield scores that are comparable from one person to another (McMillan, 2001, p.63). A number of factors that can influence the provision of fair
assessment have been identified of which the following are relevant for this research.

The identification and elimination of bias becomes more important in the increasingly culturally diverse classrooms (McMillan, 2001, p.71). In order to eliminate or to minimize bias in assessment practices, teachers need to design their own assessments based on their intimate knowledge of their learners. The teachers observed took cultural backgrounds into consideration in their choice of words and in the questions asked. Grace introduced the concept of "convection current" and first made sure that her learners (for whom English was a second language) had the same meaning for the word “current” before she continued with the lesson. Since her learners lived in an area with no big rivers closeby and the likelihood of having money to travel to the ocean to experience a current being slim, they had probably never seen something that would correlate with construction of the concept of “current”.

Another factor that can be addressed in order to provide fair assessment is to ensure that learners have knowledge of learning targets and the nature of assessment before their instruction. McMillan (2001, p.68) emphasises the importance of providing both the content of the assessment and the scoring criteria before assessment and often before instruction. Although teachers provided their learners with an indication of the content of assessments, the provision of clear learning targets and the nature of assessment were not always clear. All three teachers provided most of the instructions verbally, therefore, the criteria are not always implemented as planned. Michael’s oral presentation, where he planned to use one set of criteria, but negotiated another set with the class before the presentation and then provided feedback on another completely different set of criteria is a classic example.

Learners should also have the opportunity to learn what the teachers will expect from them in the assessment task (McMillan, 2001, p.69). Annette’s teaching style during instruction was mostly a lecture-content driven style where she would work through a workbook with questions by reading the questions, answering them and
then explaining concepts that would support the questions. This does not always prepare her learners to apply knowledge and to develop reasoning skills. In her assessments on the other hand, she expects her learners to use some reasoning skills. The match between the instruction namely, the opportunity to learn, and the assessment tasks needs to be planned carefully. Michael’s lack of clear instructions for activities minimises the opportunity learners have to learn since such activities then occurred undirected with no clear focus (see Chapter 4 for examples).

A more subtle use of unfair assessment practices is when the beautification of written work influenced the impression marks allocated, while it was not identified as one of the criteria to be used during the assessment. This practice was common with the two primary school teachers but not as prominent in the secondary school teacher’s assessment practice.

The three teachers observed during this study lacked the skills to provide fair assessment. The training that the teachers received for the implementation of C2005 focused on the administrative part of the assessments as illustrated by the Eastern Cape DoE recommendations in their training manual.

For fair assessment you should ensure that
- the purpose, method and tools of assessment is made clear before they start, and
- by using a recording sheet that is in tune with these. (ECDoE, 2000c, p. 33).

6.4.2 Valid assessment

Validity poses the questions: “Does the assessment actually assess the knowledge or skills it is designed to assess?” and also “Are the questions difficult for candidates to understand, are they culturally biased?” (Petty, 1993, p.351; Harlen, 2000, p.259). A principle of validity that features very prominently in outcomes-based assessment is the generation of criterion-referenced evidence. The class teacher can establish informal criterion-related evidence, if the assessment of a learner’s skill through observation coincides with the student’s score in a test that tests the steps used in the skill. The principle of using a variety of sources for the
collection of assessment information regarding the achievement of learning targets and not to merely relying on a single assessment is based on the generation of criterion-related evidence (McMillan, 2001, p.63).

Valid assessment strategies are those that reflect the actual intention of teaching and learning activities, based on learning programme outcomes. Neither Michael nor Grace eventually assessed what they had planned to assess. None of the teachers decided before learning commenced on the intended learning outcomes to be achieved. Valid assessments reflect the quality or extent to which the principles of integrated assessments are implemented. As a result of the lack of integrated assessment practice displayed by the sample of teachers, the validity of their assessment information is in doubt.

A wide range of modes of assessment is essential if valid judgements of progress and achievements are to be made. This range will involve what learners say and do as well as what they put on paper, and should assess what is important, not just what is easy to measure. The dominant mode will vary from one stage to the next, but it is important that the assessment remains integral to the teaching/learning process. Where possible, assessment should include:

- negotiation between teachers and learners;
- target setting which enables progress to be assessed;
- learners self-assessment; and
- peer-group assessment.

Although Michael was open-minded and negotiated the assessment criteria for his oral presentation, the lack of clear learning targets and sticking to those targets made the assessment information collected for the oral presentations invalid.

In summary, the validity of performance assessments is influenced mainly by two factors, namely, bias and mental record keeping rather than written record keeping (Airasian, 2001, p.253). Meticulous and comprehensive record keeping of assessment evidence is of the utmost importance since assessment’s overall
function is to provide valid information for decision-making (Knight, 1999, p.101). The use of a wide range of assessment techniques greatly enhances the validity of classroom-based assessment (Morrison, Busch & D’Arcy, 1994, p.196). Judgements of performances are biased when they are influenced by inclusion of irrelevant subjective criteria (Airasian, 2001, p.252) that act as distractions and are not relevant to scoring.

They did not implement a variety of assessment techniques or gather their information from a variety of sources. Annette’s assessments did not remain an integral part of the teaching/learning process. There is a lack of correlation between classroom practices and assessment practices. She does not use self- and peer assessment. Although the questions assess what she had planned to assess, the learners did not always receive the opportunity to learn what she expected in the summative assessment.

When comparing the evidence from Grace’s assessment practice, one may conclude that her assessment practices are invalid. She does not utilize self- or peer assessment. She developed broad categories for assessment criteria, but did not provide the learners with those finer expectations. She allowed the inclusion of irrelevant and subjective criteria to distract her.

6.4.3 Reliable assessment

Although reliability traditionally is concerned with the consistency, stability and dependability of the results of assessment (McMillan, 2001, p.65; Airasian, 2001, p.19), Gipps (1996, p.260) argues strongly for a re-conceptualisation of reliability for classroom-based assessment. She suggests comparability across tasks as an alternative. This argument is supported by Stones (1994, p.235). Petty (1993, p.351) and Thorndike (in Airasian, 2001, p.19) argue, “Perfect reliability is impossible to achieve”. All three teachers that were observed, displayed a common trend in the allocation of marks for projects. This was a direct result of the lack of explicitly stated assessment performances and their accompanying assessment criteria.
Assessment tasks designed for one target audience cannot be transported directly to another cultural setting. Teachers need to adapt material from the national DoE or other commercially available curriculum resource packages. When planning assessments, the teachers should be sensitive to the developmental stages of their learners, recognise the existence of multiple intelligences and characteristics of creative individuals in different domains of intelligence. Classroom assessment should acknowledge the effect of context on performance and should strive towards providing the most appropriate context in which to assess the desired competences of the learners. Michael did not take ownership of the curriculum material provided by the national DoE. He made use of the Group skills peer assessment grid just as he received it from the national DoE. Exemplars of the assessment grids are provided in Appendix B.

Annette, however, demonstrated competence in adapting material from printed resources available into written assessment questions with her specific learners in mind. Grace mimicked the new expectations through written planning, but did not adapt her classroom-based practice. The teachers are subsequently on different developmental levels in terms of their ability to adapt curriculum material for different contexts. From the evidence, it can be deduced that Annette’s strong subject knowledge empowered her to make decisions on how to adapt the available material.

When performance criteria for scoring the evidence are vague, unclear or subjective, the reliability is reduced (Airasian, 2001, pp. 254, 255). Teachers should give learners these criteria at the beginning of a section of study, or alternatively learners themselves should develop these criteria at the beginning via the facilitation of their teacher. Although Michael attempted to implement this with the negotiation of the assessment criteria during the oral presentation, it was not followed through. The learners should be informed that these criteria would be used to help assess their performance at the end of the unit. In a classroom, it is the responsibility of the classroom teacher to ensure that all affected understand the assessment criteria. The teachers themselves, therefore, need to be competent
in understanding the essence of learning outcomes and accompanying assessment criteria. This can only be achieved if the teachers are well versed in all four themes of the Natural Sciences learning area as well as in practical developments in the learning area.

In conclusion, the curriculum designed by the three teachers illustrates a lack of understanding of the new policy. Michael’s lessons were not planned as part of a cohesive whole. Annette followed the curriculum, as designed by a commercial publisher’s workbook, although she provided reflective comments about teaching in the new curriculum. Her reflections on the curriculum and the processes illustrate a level of understanding absent in both Grace and Michael’s comments. Grace combined the departmental plans with what she was familiar from the past.

6.5 Findings of the Analysis

In the observed classrooms, the reality was that a narrow range of assessment techniques and methods were implemented. The accuracy of the assessment information gathered by all three teachers is questionable because of the limited sources used for the collection of the assessment information. Michael made use of written, and oral presentations as well as teacher, self- and peer assessments (see Chapter 4 for details), but the assessment criteria were limited in range and depth. His assessment sources did not provide accurate assessment information regarding the application of knowledge and understanding. Grace only gathered information from written sources. This diminished the accuracy of her assessment information and resulted in an incomplete picture of learners’ ability to demonstrate applied competence. Annette’s assessment information was collected mainly from written sources such as examination papers and tests. Although the examination papers and the tests included the assessment of skills and the application of knowledge, it is still not sufficient to assess the complex dimensions of the knowledge base as illustrated in Figure 2.3.
When comparing Grace, Annette and Michael in terms of what happens in the class and how assessment occurs, it can be seen that Michael’s teaching was more open-ended and creative, but his testing had a narrow scope. Michael’s stronger Biology content knowledge gives him the strength to be more creative. During the observation, his lack of focus on content in his teaching was disturbing. He relied heavily on printed material for the content. Michael narrowed his focus when it came to tests (as seen in Figure 6.2)

Figure 6.2  Michael: Profile of correlation between classroom practices and assessment practices.

However, Annette had the luxury of only teaching the sections in which she had a strong content knowledge. This would have been ideal had she taken ownership of an alternate style of teaching. Her profile shows restricted methods of presentation but she uses her vast knowledge to be creative in her assessment techniques (as seen in figure 6.3).

As described in Chapter 4, Annette’s November examination paper balanced factual knowledge and conceptual knowledge. Annette moved away from the narrow focus on knowledge and made use of a variety of questions to collect the evidence. A comprehensive spread of the learning goals was assessed in the three examinations for the Grade 8s during the year that the observation was done. Knowledge as well as the application of knowledge was assessed, the demonstration of practical skills was assessed through “minds-on” assessment tasks and the social contexts and everyday life contexts were covered as well. This is illustrated by the following question in the November examination paper: Write a
short paragraph in which you explain what you can do to prevent pollution in your environment. You may use some of the ideas in the article.

This question asks the learners to address an environmental issue that will provide Annette with evidence of the learners’ attitudes towards pollution. The article provided ideas that are “hidden” and not explicitly pointed out as actions to prevent pollution. The learners had to read the article and use the information in a new and a personal context.

The examination papers were set using a combination of question types and she integrated the application of process skills and knowledge in new contexts. A selection of the examination questions is included in Appendix D.

Figure 6.3 Annette: Profile of correlation between classroom practices and assessment practices.

In contrast, Grace did not have the means of providing her learners with strong content knowledge. Her content knowledge as well as a shortage of consumable resources constrained her. As a result, her implementation was also limited. Grace uses Annette’s limited teaching styles and Michael’s limited test techniques (as seen in Figure 6.4).
In conclusion, the assessment practices of the three teachers that participated in this research, illustrate a lack of understanding of the philosophy and the practical implications of the new educational policy that they are expected to implement. Michael’s lessons were not planned as a cohesive whole. Annette followed the curriculum designed by a publisher’s activity book, although she provided reflective comments about teaching in the new curriculum. Grace mimicked the requirements of the policy documents but in her classroom it was the traditional teacher-driven assessment practices that took precedence.

The result illuminates a need for a differentiated, professional development programme that would address each teacher’s unique educational context as well as their personal attributes if its goal is to facilitate sustained change in assessment practices. The teachers are not just in need of knowledge of new trends, but also the competence to implement it individually with confidence in their own educational environment.

To conclude this data analysis, Annette’s words summarise the answer to sub-question three:

_You know, things are starting to fall in place. Yes, but there are still a lot of work to do before you would be able to handle this thing..... _

_This is one thing that I feel will allow OBE to work. Self disciplined learners, which we currently definitely not have, and a well qualified and trained teacher in his area. Not just subject knowledge, also evaluation and you must know what works. And those two things are not there yet._

She identified the requirements for a teacher to be competent in the assessment of the Natural Sciences learning area, namely:

- Expertise in the four domains of the Natural Sciences learning area;
- Expertise in assessment; as well as
- Expertise in pedagogical content knowledge.
She also identifies the need to focus on the development of a value system that would enable the learner to benefit from the assessment for learning philosophy and a willingness from teachers to implement credible assessment practices. This leads to the answering of the research questions.

6.6 **Summary of Research Findings**

The new assessment system adopted by South Africa is a radical change for both learners and teachers. It opens new possibilities of achieving the important aims of science education and is changing the subject’s boundaries in South Africa. Teachers are expected to design and to collaborate with colleagues in order to create assessment tasks on new integrated topics and then to implement appropriate teaching methods. Assessment tasks and learning experiences should cater for different contexts and levels of difficulty. Writing scenarios for interdisciplinary didactics and assessment demands more skills from a senior phase science teacher than those provided by their general training and the guidelines issued by the department.

I agree with Shepard’s (2000, p.12) view that “the abilities needed to implement a reformed vision of curriculum and classroom assessment are daunting”. As Cremin explained in 1961 (in Shepard, 2000, p.12), progressive education reform requires “infinitely skilled teachers who need to be prepared in sufficient enough numbers to sustain these complex forms of teaching and schooling”.

Therefore, a significant change is expected from the teacher. Nonetheless, this vision holds the belief that assessment practice could improve science teaching and learning. To do otherwise means that day-to-day science instructional processes and practices will continue to reinforce and to reproduce fragmented and rote learning. Central to the whole process of developing professional competence is to assign much greater importance to the part played by knowledge, understanding and attitudes and to view them as permeating and affecting practice
in an integrative way. Little is gained by the possession of a competence if one cannot judge when and how to use it.

There is a gap between the theoretical understanding of the policy documents, with its underpinning philosophy of an outcomes-based education system, and the implementation of the policies into practice as evident by assessment practices of classroom teachers. The gap can be described as that of the belief system of the teachers. Theoretically, teachers know what is expected of them, they receive training that covers the detailed step-by-step procedures that need to be followed in the classrooms, but they do not conceptualise and internalise these policies.

The government has placed the responsibility for the success of C2005 squarely on the shoulders of teachers (DoE, 1997a, p.134). The national DoE requires that “teachers will draw from their own experience to facilitate the development of learner support material to ensure that it is relevant and effective” (DoE, 1997a, p.24). This is a tremendous requirement from teachers that were never expected to do something similar in the past.

The current science assessment practices in the context of “ordinary” or average South African classrooms, as described in Chapter 4, were analysed. The aim was to establish areas of competence expected from them by the unique South African context, added to which they also experienced a need for professional development. An example is the importance of being competent in communication and subject knowledge to display competence in clarity of expression and the ability to describe the content criteria in assessment tasks in such a manner that learners can use it for self-assessment.

This study provided answers to the question:
Do the assessment practices of senior phase science teachers warrant a need for the development of an instrument to determine the minimum science-assessment competences required of these teachers?
The research question was divided into three sub-questions that shaped the research. Each question will be revisited in the next few paragraphs.

**Sub-question 1**

1. How do three senior phase teachers assess science in the General Education and Training Band?

The data collected and described in Chapter 4 answered this first sub-question. The categories used to describe the practices emerged from the literature review in Chapter 2. During the descriptions of the three participating teachers' assessment practices, as well as the profiles of their educational environments, the conclusion was that each teacher had a unique combination of strengths and weaknesses but these led to remarkably similar threats to and opportunities for their assessment practices.

Chapter 6 produced evidence that the requirements for further development of each of the three teachers differed to a certain extent. The conclusion seems to be that a customised training programme is the solution. Thus, there needs to be some instrument by which teachers can assess themselves to determine the particular type of training from which they could benefit.

**Sub-question 2**

2. What assessment competences are needed for effective science assessment in South Africa?

Chapter 5 was devoted to answering this question. This chapter was developed with the background of Chapter 2, which focused on international trends in good assessment practices after which a strategy for the assessment of science was developed. As a summary for the competences expected, assessment can be viewed as a cyclic process including four phases: preparation, assessment, evaluation and reflection. The assessment process involves the teacher as decision maker throughout all four phases.
In the **preparation phase**, decisions are made which identify what is to be assessed, the type of assessment (diagnostic, formative or summative) to be used, the criteria against which learning outcomes will be judged, and the most appropriate assessment strategies with which to gather information on learner progress. The teacher’s decisions in this phase form the basis for the remaining phases.

During the **assessment phase**, the teacher identifies information-gathering strategies, constructs or selects instruments, administers them to the learners, and collects the information on learning progress. The identification and elimination of bias (such as gender and culture bias) from the assessment strategies and instruments, and the determination of where, when, and how assessments will be conducted are examples of important considerations for the teacher.

In the **evaluation phase**, the teacher interprets the assessment information and makes judgements about learner progress. Based on the judgements or the evaluations, teachers make decisions about learning programmes and report on progress to learners, parents and other appropriate school personnel.

The **reflection phase** allows the teacher to consider the extent to which the previous phases in the evaluation process has been successful. Specifically, the teacher evaluates the utility and the appropriateness of assessment strategies used, and such reflection assists the teacher in making decisions concerning improvements or modifications to subsequent teaching and assessment.

All four phases are included in diagnostic, formative, and summative assessment processes.

Competences associated with activities occurring prior to instruction are:

- Understanding learners’ cultural backgrounds;
- Clarifying and articulating the performance outcomes expected of learners;
- Planning instruction for individuals or groups of learners; and
• Choosing assessment methods appropriate for instructional decisions.

Competences associated with activities during instruction, are:
• Monitoring progress;
• Identifying gains and difficulties;
• Adjusting instruction;
• Giving feedback;
• Motivating to learn; and
• Judging attainment.

Competences needed in using assessment when making decisions and in communicating assessment results, are:
• Describing attainments;
• Communicating strengths and weaknesses to learners and parents;
• Analysing information to inform future instructional planning;
• Evaluating effectiveness of instruction; and
• Evaluating the effectiveness of curriculum materials.

Sub-question 3
3. What is the result of combining what exists with what is needed in South Africa?

From the descriptions of the three participating teachers, it is clear that their needs are unique and varied. It would be impossible to address these needs in a programme that is so general that it is designed to suit everybody. Groups of teachers will have specific problem areas that need to be addressed specifically. For example: Annette and Michael obviously cannot attend the same course – neither will benefit. The problem, however, is that people like Michael and Grace probably do not know what their weaknesses are, as it is clear that they have many misconceptions of their abilities and interpretations. Therefore, if there is a proper tool for their use, they could evaluate their own practices to find out their shortcomings. The need for the development of such a tool is imperative.
6.7 **RECOMMENDATIONS**

Appropriate training programmes for teachers would have to take the strengths and the weaknesses of particular teachers into account for reform in assessment practices to be sustainable. Many reform documents utilise a list as a presentation format for addressing specific issues. They follow a pattern by listing the competencies or aspects of the training programmes in a hierarchical order. An advantage of this method of presentation is that it is very efficient as a means by which information is conveyed. The disadvantages are that it can send an implicit message that whatever is listed first is most important and that those elements further down the list decrease in importance. Thus, the items on the list are in a random order.

The layout or format of the training programme needs to communicate the competencies to the intended audience and to indicate equal importance. It should emphasise the inter-relatedness of the competencies expected from the teachers. Also, it should send an implicit message to teachers and teacher-educators that if any one competence was missing from the instrument, the quality of their assessment practices would be affected adversely. Teachers need to be competent in all the aspects of the training programme identified in order to produce effective assessments.

In order for these activities to be steered on the correct route, the science teacher has to guide it through a number of limiting boundaries. The boundaries are provided, firstly, by the teacher’s knowledge of sound assessment practice; secondly, by the teacher’s knowledge and understanding of the knowledge base of the sciences as illustrated in Figure 2.3; and thirdly by the teacher’s knowledge of sound communication practices. Included in the knowledge base of the sciences is the pedagogical content knowledge.

For best possible results, all three dimensions need to be at their optimum level of development. Until that point is reached, there will always be a loss in the volume and the underdeveloped dimension will act as a limiting factor to the optimum assessment competence of the science teacher.
These three dimensions cover the following aspects:

- subject expertise (which includes subject pedagogy);
- assessment expertise and
- communication expertise.

Figure 6.5 An illustration of the influence of knowledge and understanding on science assessment practices.

From this research, it became evident that the training needs of the sample of teachers are so different that a “one-fits-all” professional development programme would not provide teachers with a sustainable solution to their assessment practice dilemma. I recommend that an instrument is developed that can be used by individual teachers to determine their own science-assessment competences. This would allow them to attend professional development programmes that would address their particular needs, and take their particular education environment into account.

The training system or professional development programme for science teachers needs to be developed as a set of modular development programmes. The reason is that if identified more accurately, there is no longer a need for individuals to attend a “standard” course – they need only attend modules targeting their specific needs (Fletcher, 1997, p.32). When teachers attend a training course and the first half of the course is about familiar concepts, they do not pay attention to the last half.
In order to adopt new assessment practices, teachers would have to acknowledge the need as well as its utility. That would be a major objective for such an instrument. It should provide a mirror for teachers to reflect on their assessment practices, recognize the weak areas and the strong areas and, accordingly, plan a personal professional development strategy. The instrument needs to be explicit enough to establish the existence of a need and it should be clear and simple enough to unambiguously identify the different areas in need for training. If it does not succeed in doing that, the teachers could loose faith in its utility and switch off from the training provided, like Michael did after the generic introduction training for C2005. He preferred to get the information from teachers who attended the training, and in the process his own need would not be satisfied.

6.8 **Need for Further Research**

During this research, the need to develop an instrument for use by science teachers to determine their own science-assessment competences was established.

6.9 **Conclusion**

The primary purpose of assessment is to assist learners to advance within the required outcomes. Assessment is consequently seen as a diagnostic tool, which informs the learner and the teacher about learners’ progress. It gives the teacher information about which teaching methodologies are successful and it gives the teacher information about what additional interventions are required (ECDoE, 2000a, p.26).
References


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Appendix A

Outcomes

A-1 Critical Outcomes of the NQF
1. Identify and solve problems in which responses display that responsible decisions using critical and creative thinking have been made.
2. Work effectively with others as a member of a team, group, organisation or community.
3. Organise and manage oneself and one’s activities responsible and effectively.
4. Collect, analyse, organise and critically evaluate information.
5. Communicate effectively using visual, mathematical, and/or language skills in the modes of oral and/or written presentations.
6. Use science and technology effectively and critically, showing responsibility towards the environment and health of others.
7. Demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation.

The above are considered in terms of the following developmental outcomes.

A learner should be aware of the importance of:
8. Reflecting on and exploring a variety of strategies to learn more effectively.
9. Participating as responsible citizen in the life of local, national and global communities.
10. Being culturally and aesthetically sensitive across a range of social contexts.
11. Exploring education and career opportunities, and
12. Developing entrepreneurial opportunities (DoE, 1997b, p. 15).
A-2 Specific Outcomes of the Natural Sciences learning area of the GET band.

1. Use process skills to investigate phenomena related to the Natural Sciences.
2. Demonstrate an understanding of concepts and principles, and acquired knowledge in the Natural Sciences.
3. Apply scientific knowledge and skills to problems in innovative ways.
4. Demonstrate an understanding of how scientific knowledge and skills contribute to the management, development and utilisation of natural and other resources.
5. Use scientific knowledge and skills to support responsible decision-making.
6. Demonstrate knowledge and understanding of the relationship between science and culture.
7. Demonstrate an understanding of the changing and contested nature of knowledge in the Natural Sciences.
8. Demonstrate knowledge and understanding of ethical issues, bias and inequities related to the Natural Sciences.
9. Demonstrate an understanding of the interaction between the Natural Sciences and socio-economic development (DoE, 1997b, NS p. 7).
A-3 Learning Outcomes in the Revised National Curriculum Statements for the Natural Sciences learning area.

LO 1: Scientific Investigation
The learners will be able to act confidently on curiosity about natural phenomena, and to investigate relationships and solve problems in scientific, technological and environmental contexts.
AS1: Planning investigations.
AS2: Conducting investigations and collecting data.
AS3: Evaluating data and communicating findings.

LO 2: Constructing Science Knowledge
The learner will know and be able to interpret and apply scientific, technological and environmental knowledge.
AS1: Recalling meaningful information when needed.
AS2: Categorising information to reduce complexity and look for patterns.
AS3: Applying knowledge to problems that are not taught explicitly.

LO 3: Science, Society and the Environment
The learner will be able to demonstrate an understanding of the interrelationships between science and technology, society and the environment.
AS1: Understanding science and technology in the context of history and indigenous knowledge.
AS2: Understanding the impact of science and technology on the environment and on people’s lives.
AS3: Recognising bias in science and technology, which impacts on people’s lives (DoE, 2002b).
Appendix B
Michael

B-1 Practical test

- Burette: desired amounts of liquids
- Direct reading balance
- Finding mass of single object
- Measuring cylinder: measuring the volume of a liquid
- Gas syringe: extracting liquid out of water (F. vol. cm$^3$)
Assessment tools used for assessment of Groupwork.

Co-operative group skills assessment sheet

<table>
<thead>
<tr>
<th>TASK SKILLS</th>
<th>Student</th>
<th>Student</th>
<th>Student</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gives ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asks questions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stays on task</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follows directions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checks others' understanding</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gets group back on task</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOCIAL SKILLS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encourages others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explains ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discusses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Listens well</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Praises others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Self-assessment: co-operative work

GROUP ASSESSMENT

Names: ..................................................

<table>
<thead>
<tr>
<th>Did our group:</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>LISTEN to each other?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TALK about the task?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO-OPERATE?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUGGEST good ideas?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENCOURAGE each other?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What went well? ..........................................................

What could we do better? ...............................................

Signed: .................................................................

Fig. 1
Give the correct term for:

1. the sac in which a placental mammal’s young is kept - **placenta**
2. pouched mammals - **Young in pouch**
3. a crocodile’s reproduction + waste opening - **cloaca**
4. animals with backbones - **vertebrates**
5. animals which lay eggs are: **oviparous**

By means of a sketch and labels, indicate the difference between a shark and a fish with regard to:

6. breathing
   - **Shark**
   - **Gill slits**
   - Gills

7. mouth
   - **Fish**
   - **No sharp teeth**
   - Situated at point of head.
   - Shark teeth, situated at bottom of head

Give one example of a(n):

8. crustacean - **crab**
9. amphibian - **Frog**
10. myriapod - **centipede**

Mark: 20
Give one function of:

11. a dog's tail - keep the dog balanced
12. the down feathers of a bird - keep water off the skin
13. the lateral line of a fish - perceives vibrations to the fish and its prey
14. nictitating membrane - protects the eye ball (when eyes under water)

List two facts about a crocodile's eating habits.

- They have sharp teeth for large amounts

Describe two ways in which the hair protects the dog.

- Keeps water off the dog, keeps the dog warm, keeps water off skin

GOOD LUCK!!
Appendix C

Grace

Extracts from Grace’s tests. Underlined phrases are the answers accepted by Grace.

C-1 Test 1

9 May 2001

Science

1. Calculate the area of a square [Grace’s own words] of which the sides are 3 cm and 5 cm.
   
   Your answer must be in
   
   (i) cm $^2$ and (ii) mm $^2$

2. Calculate the area of a circle. The diameter of a tin is 15-mm.
   
   Your answer must be in
   
   (i) mm $^2$ and (ii) cm $^2$

Biology

1. Complete the following.

   a) The vertebrate class which swims with the fins is the …………

   b) What does a fish use to breath?

   c) The body of a fish is divided into three parts name them (a) (b) (c).

C-2 Test 2

The test based on the learning unit that I observed had the following aspects assessed.

1. What is energy?
   
   *Energy is the ability to perform work.*

2-7. Name six forms of energy.

   *Potential energy, nuclear energy, heat energy, kinetic energy, chemical energy, electrical energy, light energy, sun energy.*

Name at least 2 other forms of energy into which each of the following may transform.

8. Heat energy $\rightarrow$ *energy of movement*

9. electrical $\rightarrow$ *light energy*

10. energy of motion $\rightarrow$ *light energy*
C-3 Test 3
8 Aug 2000

1. The petunia has a tap root.
2. The veins in the leaf of a petunia are arranged parallel to one another.
3. Petunia stem is covered with hairs.
4. Petunia bears flowers.
5. Petunia flowers have 5 petals.

Question 2

1. Dicotyledons have a tap root system.
2. Dicotyledons leaves are net veined.
3. All petals together form the pistil.
4. All sepals together form the calyx.
5. Ovules lie in the ovary.

C-4 Practical test

Answer the following questions.

1. The volume of water was 175,6 cm$^3$ and the volume of the water plus stone was 196 cm$^3$. Find the volume of a stone only.

   \[
   \begin{align*}
   \text{Volume of water was} & = 175.6 \text{ cm}^3 \\
   \text{Volume of water + stone} & = 196 \text{ cm}^3 \\
   \text{Volume of stone} & = 175.6 - 196 \text{ cm}^3 \\
   & = 20.4 \text{ cm}^3 \\
   \end{align*}
   \]

2. What do we call this method?

   Liquid displacement method.

3) The volume of an irregular body may be found by a method called liquid displacement.

[The answer of Question 1 is directly copied from a learner’s response and it was marked correct.]
Appendix D
Annette

D-1 Extract from November 2001 test.

7.2 Use your tin, string and the ruler and measure the following aspects of the tin. Write your measurements down on the examination paper.

7.2.1 The height of the tin in cm.
7.2.2 The circumference of the tin in cm.
7.2.3 The diameter of the base of the tin.

7.6 Carefully look at your tin and determine whether your tin is manufactured from steel or aluminium. Write your answer down and provide a reason for your conclusion.

[The differences between steel and aluminium tins were given in the article by means of a labelled sketch. This question asks them to apply the information and classify their own “unknown” tin.]

7.9 You are collecting tins and would like to sell it to a recycling company. You have a mixture of aluminium and steel tins. Name two methods according to which you can sort the tins quickly and easily.

8.1 Look at your tin and see if you can find the given sign on the tin. What does that mean?

8.2 Write a short paragraph in which you explain what you can do to prevent pollution of the environment (you could use the article to help you).
**HET JY GEWEET?**

Aluminium is die derde volopste element in die aardkorst. Die volopste element is suurstof en die tweede volopste element is silikon. Aluminium word veral aangetrof in die mineraal bouksiet, vermoen na die dorpie Les Baux in Frankryk, waar dit tot vandag toe volop voorkom. Bouksiet bevat die verbinding Al₂O₃. Aluminiumbindings kom ook in Mosambiek voor en daar is ’n groot aluminiumsmeltery in Richardsbasie.

**ALUMINIUM IS WAARDEVOL!**

Baie van ons koeldrankblikkies word van aluminium gemaak asook kastrolle, vliegtuigpanele, fiets, lere, vensterrame, ens. Waarom is aluminium so waardevol?

Aluminium
* roes nie
* se digtheid is klein in vergelyking met dié van die ander metale
* -produkte kan baie vinnig afgekoel of verhit word
* is lig
* is baie sterk
* kan oor en oor gebruik word

Suid-Afrika vervaardig ongeveer 400 miljoen aluminiumblikkies per jaar, terwyl daar wêreldwyd sowat 3 500 miljoen aluminiumblikkies vervaardig word. Daar word sowat 200 000 miljoen blikkies per jaar verkoop.

Wanneer ’n aluminiumblikkie herwin word, word 95% van die energie wat gebruik word om een blikkie te maak, bespaar. Omdat aluminium ook nie roes nie, kan al die metaal herwin word. Baie energie word sodoende bespaar.

Baie koeldrankblikkies word ook nog van staal gemaak. Die verskille tussen staal- en aluminiumblikkies is die volgende:

- gladde nek
- nie-magneties
- blink basis
- gerifte nek
- magneties
- dowwe basis

**ALUMINIUM EN DIE OMGEWING**

* Die mastskappe wat aluminium myn, doen besonder baie moeite met die omgewing.
  Sodra ’n gebied klaar gemyn is, word die plantegroei weer herestig.
* Die smeltery het baie streng maatreëls om besoedeling te voorkom
* Die meeste energie wat gebruik word om die aluminium te produseer, word uit hidro-elektrisiteit verkry
D-3 Formative assessment – feedback given during marking of workbooks.

7. Use the following words to describe the forces that work:

- affect
- newton
- attract
- magnetic
- electric
- repel
- gravity

8. Explain why the speedometer in a car shows the speed of the car:

- constant speed: the car is moving at a constant speed.
- zero speed: the car is stationary.
- high speed: the car is moving at a high speed.

9. Motor powered car: If the constant speed of the car changes, what will happen to the force acting on the car? Explain this with a diagram and a description.
## D-4 Projects

Project 1. Illustration for the construction of the balance as part of project 1 (reference section 4.5.3)

Project 2: Assessment grid (reference section 4.5.3).

### Project Evaluation form – Grade 8

Scheme used for the marking of the Task:

<table>
<thead>
<tr>
<th>Did not hand in</th>
<th>Handed in late without making arrangements</th>
<th>Handed in late with prior arrangement</th>
<th>Handed in on time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. First impression (face value)</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Pictures, illustrations, charts, tables, diagrams, + quality,+ completeness, labels, applicability</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4. Bibliography</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5. Table of contents, arrangement of material, neatness, etc.</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6. Content: Choice of theme, originality. Applicability</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>---</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>7. Content: Correctness, scope/depth of reading, research done.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Additional information.</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>9. Quality of research done</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>10. Integration of project with content done in class.</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total: 50**