AN EXPLORATION OF FORMATIVE ASSESSMENT IN PRIMARY SCHOOL NATURAL SCIENCES CLASSROOMS

A thesis submitted in fulfilment of the requirements for the degree of

MASTER'S IN EDUCATION
at
RHODES UNIVERSITY

by
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14M0010

January 2019

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The financial assistance of the National Research Foundation (NRF) South Africa toward this research is hereby acknowledged and Fundisa for Change project. Opinion expressed and conclusions arrived at, are those of the author and are not necessarily to be attributed to the NRF.

DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and has not previously in its entirety or in part been submitted at any university for a degree.

Signature: _____ Date: 15 February 2019

ABSTRACT

This research investigated formative assessment in primary school Natural Sciences classrooms. The intention was to explore how teachers use formative assessment strategies to raise classroom standards and to foster higher order cognitive development of learners. My interest in the study was influenced by constant poor achievement of South African learners in literacy and specifically in scientific literacy reported in various international and national benchmark tests.

Vygotskian theory of the zone of proximal development was used to provide critical insight into formative assessment processes. Further theoretical lenses included Wylie and Lyons' (2013) 'Ten dimensions of formative assessment' work for reviewing formative assessment strategies and Dalton's (2003) 'New Bloom's Taxonomy' for insight into cognitive development in classroom contexts.

Influenced by the above mentioned reports, a qualitative case study of seven primary school teachers in Cape Town, Western Cape, South Africa was conducted. Underpinned by an interpretive paradigm and driven by the desire to achieve an in-depth understanding of the case under study, three techniques for data generation were employed. The first technique was semi-structured interviews. The second technique of data generation was through lesson observations including pre-lesson discussions and stimulated recall interviews. Observations were conducted to record teachers' formative assessment practices and report how they use the formative assessment strategies to support student learning or 'shifting' their zone of proximal development through formative assessment practices. The third technique was document analysis of lesson plans, teaching and learning activities and assessment tasks worksheets of the two teachers observed. Documents were analysed to gain insights and understanding of how teachers prepared teaching and learning activities and assessments to support learner cognitive development.

There were four data analysis phases. Phase I was an analysis of the semi-structured interviews. These were analysed to get a sense of teachers' perspectives, experiences and challenges regarding formative assessment practices. In order to get a better sense of the quality of formative assessment, classroom observations were analysed using the lens of Wylie and Lyon (2013). This was analysis Phase II. Phase III made use of Dalton's 'New

Bloom's Taxonomy' to gain insight into the role of formative assessment in supporting low, medium and higher order cognitive development. This phase was the document analysis and involved a review of the lesson plans, teaching and learning activities and formative assessment tasks. Phase IV further explored teachers' experiences regarding implementation of formative assessment. Phase IV is different from Phase I in that it was not only looking at what teachers highlighted as challenges but also at challenges experienced during the lesson observations. This analysis was done across data sources, that is, semi-structured interviews, lesson observations and stimulated recall interviews.

Findings from the first set of data showed that teachers viewed formative assessment implementation as a useful practice in the teaching and learning process. However, the diverse views showed lack of clarity of the purpose and definition of formative assessment. The results also revealed some effective attributes of formative assessment were observed during lesson observations at the time of the investigation. However, the results showed that clarifying goals, feedback and classroom collaborations were weakly implemented. These seem to be strategic entry points to begin strengthening the effective implementation of formative assessment classrooms. Supporting teachers regarding use of formative assessment techniques could be one of the means of helping teachers in collecting evidence of student learning. The teachers highlighted some challenges they experienced when implementing formative assessments. Hindrances to implementing effective formative assessment practice reflected structural, technical and attitudinal challenges.

The study recommends that since formative assessment is a fundamental part of teaching and learning, teachers need more support and time for reflection to improve their implementation of effective formative assessment. The study also revealed that teachers need enough time to be able to implement effective formative assessment practices. This requires curriculum developers and administrators to revisit curriculum coverage in terms of breadth and depth and to give more time for the implementation of effective formative assessment practices.

ACKNOWLEDGEMENTS

I would like to thank the Almighty God for giving me this opportunity to do this study and complete it despite the challenges.

I would also like to thank the Schools Development Unit director, Dr J. Clark, and my colleagues for their encouragement and undying support during the study.

I would further wish to thank my family and a special thanks to my children, Bathandwa, Dumisani and his wife Pam, Noluthando and Bulelani and all my grandchildren for their support financially and otherwise.

In addition, I would like to thank all my friends; their prayers and words of encouragement were a source of strength. A special thanks to my mentors, Mr and Mrs David Makola, Mrs Wendy Msuseni and her family, Miss T. Rudah and her mother Mrs P. Rudah and Mr Andrew Petersen for their support throughout the duration of this study.

To my friend and colleague Ms Susan Brundrit, without you this journey would have ended before it even began. Thank you so much for your encouragement, support and those wonderful moments we shared together at Makana Resort in Grahamstown, for opening your house so that I could have quiet place to do my work. A special thanks to your husband Mr Philippe Carosin who continuously supported us and fed us with his delicious meals – we never went hungry. Thanks Philippe! A special thanks to Dr Ingrid Schudel for believing in me and making it possible for me to be part of the Fundisa for Change research team at Rhodes. The support and guidance I received from Dr Schudel was amazing and if it were not for her love of her work, I wouldn't have completed this study. It has been a difficult journey but you have made it worthwhile not only for me but for my family and hopefully for the other people that will use my work. Thank you. I would also like to thank Environmental Learning Research Centre staff members, for their continued support through the discussions and interchange of ideas which gave direction to my study. Their collaborative spirit of working together was amazing and gave me strength to forge on even though it was tough. I also thank my fellow classmates who were a source of inspiration throughout.

Finally, I would like to thank the two schools and the seven student-teachers who participated in this study. Their positive contribution, patience and cooperation are highly appreciated.

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LIST OF ACRONYMS

ACT	Advanced Certificate in Teaching
CAPS	Curriculum and Assessment Policy Statement
C2005	Curriculum 2005
DoE	Department of Education
DBE	Department of Basic Education
DHE	Department of Higher Education
ESD	Education for Sustainable Development
GET	General Education and Training
GETC	General Education and Training Certificate
IQMS	Integrated Quality Management System
OBE	Outcomes Based Education
NCS	National Curriculum Statement
NGO	Non-Governmental Organisation
NPA	National Protocol for Assessment
NPPPP	National Policy Pertaining to Programme and Promotion
RNCS	Revised National Curriculum Statement
UCT	University of Cape Town
WCED	Western Cape Education Department
ZPD	Zone of Proximal Development

CHAPTER 1: INTRODUCTION AND RESEARCH BACKGROUND

1.1 Introduction

Teaching and assessment practices are two important aspects of learning that have received increasing attention from educators, education policy developers and research experts in recent decades. This is evident in the South African basic education curricular developments. The current National Curriculum Statement Grades R – 12 stipulates what is to be taught and assessed in the education sector. The teaching approach adopted in South Africa after 1994 was that of outcomes-based education (OBE), with Curriculum 2005 (C2005) being the curriculum developed for South Africa. C2005 was launched in March 1997 and implemented in phases from the beginning of 1998. Constituting the foundation of the South African curriculum approach, was a learner-centred, results-oriented approach to learning based on the beliefs or assumptions that all learners must be granted the opportunity to reach their full potential; that the learning environment should create a culture of learning; and, that all stakeholders involved must be cooperating partners (Van der Horst & McDonald, 2003). In doing so, the process of learning was considered as important as the content. By spelling out the outcomes to be achieved at the end of the process, both the process and the content of education are emphasised. To encourage learner-centred and activity-based approaches to education, it was essential to fix the existing curriculum (South Africa. Department of Education [DoE], 2002).

Soon after its introduction, C2005 was met with criticism on theoretical grounds and based on reflections made regarding learning in the critical areas like reading, writing and counting (Jansen, 1999). Some of the fundamental problems highlighted within C2005 included language and terminology, lack of specified content and assessment design and a lack of teacher training and support for implementation of the curriculum (Dada, Dipholo, Hoadley, Khembo, Muller & Volmink, 2009). These factors led to a revision of C2005 in 2001. The National Curriculum Statement (NCS) was developed, which was consequently strengthened and streamlined into the Revised National Curriculum Statement (RNCS). The RNCS built on the principles and purposes and thrust of C2005 emphasising constitutional and democratic values, as well as education for justice and social citizenship with a view to a non-racial, non-sexist, and democratic South Africa. The resulting RNCS, however, still suffered from lack of clarity and many of the same problems as C2005. It continued to fall

short in terms of curriculum coverage and training or preparing teachers for implementation. It was under this growing pressure that the Minister of Education again proposed a curriculum review in late 2009 that called for "going back to basics". Some of the reasons for the RNCS failure were a lack of teaching the basics and a lack of good assessment practices (Dada, et al., 2009).

In 2011, South Africa implemented a new curriculum which combined the two National Curriculum Statements for Grades R-9 and Grades 10-12 into a single document, which was called the National Curriculum Statement (NCS) for Grades R-12 (South Africa. Department of Basic Education [DBE], 2011a). The NCS Grades R-12 represents a policy statement for learning and teaching in South African schools and comprises the following documents:

> *A Curriculum and Assessment Policy Statement (CAPS) for all approved subjects including Natural Sciences, National Policy Pertaining to Programme and Promotion (NPPPP) requirements of the National Curriculum Statement (NCS) Grades R-12; and National Protocol for Assessment (NPA) Grade R-12.* (South Africa. DBE, 2011b, p.3)

These three documents contain complementary information around assessment. The relationship between these documents is illustrated in Figure 1.1 below.

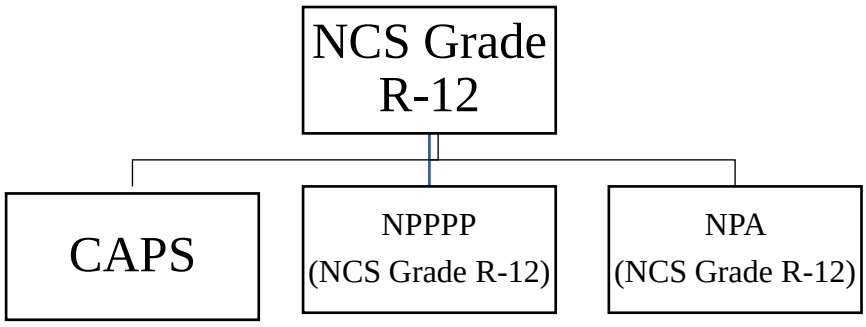

Figure 1.1: Current South African basic education curriculum

The National Curriculum Statement Grades R-12 aims to produce learners that are able to:

> *identify and solve problems and make decisions using critical and creative thinking; work effectively as individuals and with others as members of a team; organise and manage themselves and their activities responsibly and*

> *effectively; collect, analyse, organise and critically evaluate information; communicate effectively using visual, symbolic and/or language skills in various modes; use science and technology effectively and critically showing responsibility towards the environment and the health of others; and demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation.*
> (South Africa. DBE, 2011b, p.5)

These aims have implications for what is happening in the classroom and at all schooling contexts. When teachers are thinking about what to teach, how to teach and how to assess what was taught, they need to think about and try to bring out the curriculum aims. A number of researchers (Hiebert, Gallimore, & Stigler, 2002; Newmann, Bryk, & Nagaoka, 2001) have investigated aspects of the learning environment in order to ascertain the kind of education that would best prepare learners for real-life challenges – education that would prepare them to solve problems and not be confined by what is happening in the classroom but look beyond school boundaries. Recognising the impact of the learning environment on learning, the South African Department of Education introduced the CAPS which is geared to improved classroom teaching and learning and assessments. The policy outlines Specific Aims or criteria for each subject to serve as benchmarks for evaluation.

The CAPS for each subject – including the Natural Sciences – stipulates the aims, scope, content and the assessment. Pacing and sequencing of the CAPS is more structured than in the previous curriculum. The CAPS explicitly outlines the content knowledge to be taught and assessment requirements relevant to each grade (South Africa. DBE, 2011b). The Natural Sciences CAPS is geared towards "providing learners with opportunities to make sense of ideas they have about nature" (South African, DBE, 2011b, p. 10).

There are three specific aims in Natural Sciences:

> ***Specific Aim 1:*** *'Doing science'*
>
> *Learners should be able to complete investigations, analyse problems and use practical processes and skills in evaluating solutions. This aim promotes the importance of enquiry-oriented teaching.*
>
> ***Specific Aim 2:*** *'Knowing the subject content and making connections'*
>
> *Learners should have a grasp of scientific, technological and environmental knowledge and be able to apply it in new contexts. This aim*

> *addresses the need to encourage learners to construct their own knowledge.*
>
> ***Specific Aim 3:*** *'Understanding the uses of science'*
>
> *learners should understand the uses of natural sciences and indigenous knowledge in society and the environment. The learners need to perceive the interplay between their school experiences and the world beyond the classroom. (South African, DBE, 2011d, p. 10)*

In 2005 the Integrated Quality Management System (IQMS) was implemented in the South African education system (South Africa, 2013) with the aim of strengthening the quality of the educational system. The first four performance standards in the IQMS instrument are: "creation of a positive learning environment; knowledge of curriculum and learning; programs, lesson planning, -preparation and -presentation; and assessment" (Booyse and du Plessis, 2008, p. 40).

The above performance standards are directly addressing the way CAPS should be implemented or are in support of what is expected in the schooling environment. Adhering to these performance standards helps one to measure one's own teaching and learning quality. These performance standards also address the aim of the NCS-Grades R-12 which is to "develop a well-rounded individual who can identify and solve problems using scientific and technological strategies, individuals who are self-regulated and team players. Individuals who can demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation" (South Africa. DBE, 2011b, p. 10).

This suggests that through IQMS, teachers are developed and equipped with skills necessary to master issues associated with curriculum policy and curriculum implementation, recognising that teachers at all levels are key contributors to the transformation of education in South Africa. They have a key role to play and need to be able to produce the envisaged learners as described above. Implementation of these roles requires teachers who are flexible and ready to face challenges as in the CAPS. For these roles to be implemented, teachers need to be well prepared since the successful execution of any curriculum is dependent on the teachers who implement it.

The involvement of all stakeholders (including learners) is also crucial for the success of the curriculum implementation. One of the key performance indicators in the IQMS, under performance standard 3, is learner assessment and achievement (South Africa, 2013). Criteria

1 of this standard deals with feedback to learners. Teachers are rated on whether assessment tasks are marked and returned to learners timeously, feedback is meaningful and regular, and if feedback is incorporated in future lesson planning. By implication therefore, teacher educators and/or professional developers need to prepare both pre-service and in-service teachers to meet the demands of the educational policy. In this study, one of the aspects that is explored is how teachers view the role of feedback and/or use feedback in the process of teaching and learning.

1.2 Continuing teacher professional development and self-efficacy

The South African Teacher Development Summit of 2009 called for the development and subsequent implementation of a new, strengthened, integrated plan for teacher development in South Africa, which would respond effectively to the current challenges being experienced. One of the seven categories or groups of recommendations reported in the 2009 *Integrated Strategic Planning Framework for Teacher Education and Development in South Africa* summit report was continuing professional development (group E) (South Africa, DBE & Department of Higher Education [DHE], 2011). The recommendation was to identify and/or develop continuing professional development courses that are pedagogically sound, content rich, curriculum relevant and quality assured. One of the purposes of this recommendation was geared towards capacitating teachers to enhance their problem-solving abilities, develop their competences in teaching and improve their classroom management skills. These kinds of activities were meant to support teachers in the implementation of the CAPS.

1.2.1 My role in continuing teacher professional development and capacity building

The Schools Development Unit of the School of Education in the University of Cape Town (UCT) is at the forefront of fulfilling one of the roles of the university, to improve the quality of the education in the Western Cape and other South African provincial regions. The overall aim of the Unit is to develop quality education and learning in the fields of mathematics, the sciences, literacy, and life skills, through school-based work, materials development, and teacher training, within the framework of the national curriculum. I joined the Schools Development Unit in 2003 as an Education Specialist (sciences) and worked in different projects, including: university endorsed short courses; school-based support; formal qualifications such as the General Education and Training Band, Advanced Certificate in

Education and Advanced Certificate in Teaching; and the development of quality teaching and learning materials, including online resources.

In 2014, as the Schools Development Unit science team, we joined the Fundisa for Change consortium. The Fundisa for Change programme is a partnership programme for government, parastatals, environmental organisations and teacher education institutions which aims at strengthening continuing teachers' professional development. In the Fundisa for Change programme, teacher environmental education capacity-building is achieved through working to improve the environmental content knowledge, teaching practice, and assessment practice of teachers (Fundisa for Change Programme, 2013). My two colleagues and I were interested in the programme and we took part in almost all the Fundisa for Change 'training-the-trainers' and started to develop and deliver short courses under the name of Fundisa for Change.

Even though this study's relevance is not limited to environmental learning, it was working with the Fundisa for Change team of researchers, that I saw the need to strengthen effective teacher formative assessment implementation. I have adopted the definition by Egbo (2011, p. 11) that capacity building "at its most basic analysis, has to do with the allocation of, and investment in resources – physical, intellectual or human, especially when other intervening variables have failed within a given institutional or social context". He further argued that for capacity building to be effective, it should respond to the growth and development needs of the individual as well as those of the relevant institutions.

My interest in formative assessment as a way of raising classroom standards was influenced by reading an article 'Formative assessment: Raising standards through classroom assessment' by Paul Black (1998). It was not the first time I had heard about formative assessment but the article made it clear to me that using formative assessment meaningfully could be one of the tools to help our schools. The metaphor of a 'black box' used in this article refers to the importance of what is happening in the classroom and how teachers are the key drivers of this. For this reason, I decided first to get a sense of teachers' views around formative assessment so that I could have a better understanding of how teachers could be supported.

The work I do at the Schools Development Unit strives to foster teacher self-efficacy. Friedman and Kass defined teacher self-efficacy as:

> *The ability to motivate and impart knowledge, values and morals to learners; ability to improvise when unforeseen classroom situations arise; ability to overcome disciplinary infractions without much effort; assertiveness toward school administration; mastery of the whereabouts of the school political and social systems, resourcefulness; involvement in the foci of influence within the organization.* (2002, p. 678)

Working with teachers in different projects in and outside their schools, I strive to achieve this despite numerous challenges. Natural Sciences teachers are expected to integrate environment and sustainability content knowledge in their teaching of Natural Sciences within a curriculum that is content referenced. CAPS expect Natural Sciences teachers to be knowledgeable about environment and sustainability content knowledge for them to be able to teach and assess it. Considering this, I took interest in exploring teachers' understanding, experiences and challenges regarding formative assessment, hoping that the results of this study would not only inform the planning and the teaching of formative assessment but also inform the Department of Education and other teacher professional developers that are working in the field of assessment.

1.2.2 Research interest

My research interest lies in trying to understand teachers' perspectives, practices and challenges regarding formative assessment. The interest in the pedagogical content knowledge integral to formative assessment was influenced by the work of Black and Wiliam (1998a, 1998b) who did a review of formative assessment; Black's (1998) article, 'Formative assessment: raising standards inside the classroom; and Black and Harrison's (2004), 'Science inside the Black Box: Assessment *for* Learning in the Science Classroom'. One of Black and Wiliam's findings was that enhanced formative assessment classroom practices indicated success in learner achievement.

According to Edwards (2014), quality formative assessment encourages teachers to find ways that will engage learners in tasks that will allow them to use subject-based knowledge and language and/or representations in the process of developing learners in the process of learning; and it is important that such tasks precede formal assessment (summative) tasks. This challenge influenced the interest in this study in how learners are supported to engage in

tasks that can promote low, medium and higher order thinking through formative assessment processes. Not much research has been done around formative assessment and in how teachers could be supported through teacher professional development, as compared to research on formal assessment (Stear & Gopal, 2010; Vandeyar & Killen, 2007; Pryor & Lubisi, 2002).

1.3 Problem statement

The CAPS Natural Sciences challenges teachers to plan assessment tasks that sharpen learners' critical thinking (South Africa. DBE, 2011b). However, various studies reported a poor achievement of South African learners in literacy and specifically in scientific literacy. To mention a few, the Third International Mathematics and Science Study (TIMSS) (1996 and 1998); the Trends in Mathematics and Science Study (2015); and the Annual National Assessment (ANA) (2013) programme. In the study conducted by Human Science Research Council, Reddy (2006) reported that the South African Grade 8 learners scored the lowest of 50 participating countries in both mathematics and science.

In the recently conducted Southern and East African Consortium for Monitoring Education Quality (SACMEQ III, 2007) survey of Grade 6 mathematics and reading, South Africa performed below most African countries that participated in the study. An alarmingly high proportion of Grade 6 learners have clearly not mastered even the most basic reading and numeracy skills. According to Webb (2009), on average, learner performance in Grades 3, 6 and 9 in language, mathematics and science is lower than expected in terms of age.

Another part of the educational problem addressed in this study is Yore and Treagust's (2006) argument that not enough emphasis is being placed on learners' cognitive tools and their communication abilities for the learners to further develop their scientific ability. In other words, learners' thinking about science, and reading and writing about science were not being developed to their full extent. Engaging with the text and responding to questions during the lesson is one of the five 'key strategies' of formative assessment. In the CAPS, Natural Sciences document, it is clearly stated that learners need to be able to read and write:

> *The ability to read well is central to successful learning across the curriculum. Writing is also a powerful instrument of communication. Writing allows learners to construct and communicate thoughts and ideas*

> *coherently…. Learners are required to read and write particular genres of texts (including instructions, reports and explanations) during Natural Sciences lessons. The ability to read and write well is also critical when learners are assessed, both informally and formally.* (South Africa. DBE, 2011b, p.12)

Reading and writing is one of several challenges facing Natural Sciences teachers in South Africa today as highlighted above. Encouragingly, according to the 2013 ANA report, there was some improvement in literacy in learner performance (South Africa. DBE, 2013). The literacy dilemma poses a challenge for learners to perform effectively in the Natural Sciences since they need literacy for developing and supporting higher order thinking in this subject (Webb, 2009; South Africa. DBE, 2011)

However, the problem is broader than basic literacy. The South African National Education, Evaluation and Development Unit (NEEDU) report explains that:

> *If a teacher does not construct tasks to elicit higher order comprehension and problem-solving processes in her learners in class (teacher competence), it must be because she does not understand how they function in developing cognitive capacity, which in turn is certain to arise if she does not herself undertake complex problem-solving activities or apply the perspectives of inference, interpretation and evaluation (disciplinary knowledge) to her own appreciation of her effective teaching.* (National Education, Evaluation and Development Unit, 2012, p.30)

Competence with content and pedagogical content knowledge is also key to assessment processes as teachers need to be confident with content knowledge to formatively and summatively assess learners' knowledge and skills. Also, teachers need to know ways of building learners' knowledge and skills (a part of pedagogical content knowledge) to support formative assessment processes. This entails teachers developing the skill to think about how learners understand the curriculum content while at the same time thinking about how they can assist learners to progress in their learning.

Teachers are expected to use formative assessment as a way of understanding how learners learn. Black (1998) since then has argued for an urgent need for reframing policy to develop and support classroom assessment as a means of raising standards. Adler, Moletsane, Pournara, Taylor and Thorne (2009) reported a notable absence of research on primary mathematics and science teacher education: "We do not know enough about the kind of quality of domain knowledge primary teachers need, and in what ways such knowledge is

effectively developed" (p. 38) They further suggested that: "a first component of a research agenda for mathematics and science education is to examine teacher education itself, attending to the …breadth and depth of the knowledge domain, subject content and pedagogy and how … these play out" (Adler et al., 2009, p. 39).

This study considers how primary science teachers (students in the Advanced Certificate in Teaching (ACT) program) implement formative assessment to support student learning. Specifically, it explores how they use formative assessment strategies as a means to raise classroom standards and foster higher order cognitive development of learners.

1.4 Significance of the study

In the light of the educational problems highlighted in Section 1.3, the focus of this study was firstly, to explore teachers' views regarding formative assessment and perspectives on how certain challenges, such as language, hinder or enable the process of formative assessment in their classroom. Secondly, the study sought to understand how teachers employ formative assessment strategies to prepare learners to meet higher order thinking demands (which will be elaborated in Chapter 2). The study seeks to explore how teachers mediate learning to facilitate shifts in a learner's zone of proximal development (ZPD) and to support the self-regulation of student learning through effective formative assessment practices.

This study can contribute to the Fundisa for Change teacher professional development programme and the Department of Basic Education as its results will help to focus the professional development they plan for teachers. For participating teachers, this will serve as a window into their own practice and make them more aware of the different formative strategies they can use to support quality teaching and learning. The use of the Wylie and Lyons' (2013) 'Ten dimensions of formative assessment' and its grading tools in the study will be helpful to subject advisors, subject head of departments and teachers because it offers criteria for evaluating the use of formative assessment strategies.

The goal of the study was to investigate how teachers use formative assessment strategies as a means to raise classroom standards and to foster higher order cognitive development of learners. According to Hayes, Mills, Christie and Lingard (2006), improving classroom

practice is a key factor in a school improvement plan. It was Black and Wiliam's (1998b, p. 10) argument that "what needed to be changed was what happened inside the classroom and that this could be done only by changes put into direct effect by the teachers and *learners in the classroom".* Supporting in-service teachers' formative assessment practices could be one of the aspects that could improve classroom practice. Using effective formative assessment skills could result in improved content knowledge. When teachers frame or create better learning experiences for learners through using effective teaching and assessment strategies for science content, including environmental content, to ensure all learners are ready not only for examinations but also to apply the knowledge gained beyond the classroom, they are more likely to see the gains in learner achievement (Wylie & Lyon, 2013; Stiggins & Chappuis, 2005).

1.5 Research questions

In this study, the intention was to explore how teachers use formative assessment strategies as a means to raise classroom standards and to foster higher order cognitive development of learners. Specifically, it sought to answer the following question:

What are teachers' perspectives, experiences and challenges regarding formative assessment and how does this contribute to cognitive development in learning processes? This question is supported by the four sub-questions:

Sub-question 1: What are teachers' perspectives regarding formative assessment in their classrooms? The answer to this question provided insight into how teachers understood and perceived policy directives, rationale and techniques for formative assessment; and their experiences of putting these ideas into practice.

Sub-question 2: What formative assessment strategies and techniques do teachers use in classroom situations? This question required a description of how teachers implemented formative assessment. The analysis for this question made use of the 'Ten dimensions of formative assessment' (Wylie & Lyon, 2013) for evaluating the quality of strategies employed by the teachers.

Sub-question 3: How do teachers and learners use teaching and learning activities and assessment tasks to support learner cognitive development and promote quality learning and

teaching? The answer to this question provided insight into teachers' formative assessment practices with emphasis on lesson planning that included lesson objectives or goals; teaching and learning activities; and assessments. The answer to this question also provided insight into how lesson objectives, teaching and learning activities and assessment tasks were aligned to promote quality teaching and learning. Dalton's (2003) 'New Bloom's Taxonomy' was used as a lens to look at alignment between learning objectives, teaching and learning activities, and assessment components. This gave insight into the quality of the implementation of formative assessment strategies reviewed for this study.

Sub-question 4: What are the factors that hinder the effective implementation of formative assessment practices? The answer to this question provided insight into structural, material, learner participation and language challenges regarding formative assessment implementation.

1.6 Definition of terms

This section contains terms that are extensively used in this study. The following terms are defined to give clarity on how they are used in the study.

Assessment practices: These are different measures and tasks employed by the teacher to assess learners' academic progress because of their learning.

Alignment: This refers to the links between lesson objectives, classroom teaching and assessment practices.

Authentic assessment: This refers to activities that present real-world challenges and require learners to apply relevant knowledge and skills they acquire from their exposure to various in-classroom and/or outdoor teaching strategies.

Classroom teaching: This refers to all teaching strategies or techniques employed and experiences created by the teacher through teaching activities to effectively deliver the subject content to the learners.

Quality teaching: Quality teaching refers to whether specific teaching practices employed by the student-teachers were supporting learners' learning of a broad range of cognitive, social and specific academic skills.

Quality learning: Quality learning in this study refers to learning that fosters an individual learner's ability to acquire knowledge and understanding which is utilised within real situations to make valid, informed decisions, and enhances the individual's ability to be positively involved in the sharing of ideas, understanding and opinions.

Teachers: This refers to the in-service teachers who were enrolled for the Advanced Certificate in Teaching programme at the University of Cape Town and voluntarily participated in the study.

1.7 Overview of the study

This chapter presented how the study arose and how the interest in formative assessment as a way of changing the status quo in the science classroom developed. The research goals and questions were also presented.

Chapter 2 presents an overview and discussion of literature relevant to this study. The chapter Begins by discussing relevant theoretical frameworks that underpin the study, namely, Vygotsykian theory, Bruner's theory of scaffolding and formative assessment theory. In Chapter 2, the available literature is reviewed to gain some understanding of how formative assessment has been implemented in other countries. The literature is also reviewed to understand how formative assessment strategies could improve teaching and learning in South African classrooms. The discussion continues by looking at assessment in general; assessment in the South African curriculum reforms and the structure of the curriculum regarding assessments (formal and informal); and formative assessment. Lastly, the chapter considers learner conceptual development.

In Chapter 3, a detailed description of the research design, data generation techniques, the instruments used to generate data, data management and data analysis is presented. Issues of validity and ethics are also addressed in this chapter.

In Chapter 4, the findings are presented in four phases: results from the semi-structured interviews are presented in Phase I; lesson observations are presented in Phase II; document analysis is presented in Phase III; and challenges regarding formative assessment implementation are presented in Phase IV.

Chapter 5 discusses the findings, recommendations arising from the research study and recommendations for further research.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In the previous chapter the background to this study was introduced. The problem of poor achievement of South African learners in literacy and underperformance in science was presented. To address these problems, a research question supported by four sub-questions was posed. In this chapter, the research questions are revisited in terms of current literature. As described in Chapter 1, and as the title of the study suggests, this research is an exploration of formative assessment in learning processes in Natural Sciences classrooms.

This chapter begins by discussing Vygotsky's sociocultural theory of social interactions and the zone of proximal development (ZPD). The concept of ZPD is used to give insight into teaching in the classroom. Related to the concept of ZPD is the concept of scaffolding as suggested by Bruner (1993). The concept of scaffolding is also used to explain pedagogy regarding implementation of formative assessment strategies in the classroom. The current structure of the South African curriculum, which focuses on a combination of both content and assessment, is described. The chapter further looks at assessment in general and assessment in the South African curriculum. A theory of formative assessment is also presented in this chapter. Lastly, to deepen insight into the focus of classroom-based assessment, Dalton's (2003) 'New Bloom's Taxonomy' is discussed which provides insight into cognitive development processes.

2.2 Sociocultural theory – Vygotskian theory

Sociocultural approaches to learning emphasise the interdependence of social and individual processes in the co-construction of knowledge. Socio-cultural theory proposes that interpersonal social interactions, or cooperative human activities are only possible because of the different communities or environments that we grow up and live within. These communities could be our homes, churches or schools. Blanck (1990) considered school the best laboratory of human psychology. Sociocultural theory focuses on how teachers and peers influence a student's learning and how the community and culture around them influences instructional acquisition of knowledge (Cole, 1996).

Socio-cultural theory thus presents the way in which a learner constructs reality and makes meaning as influenced by social and cultural factors as well as personal and physical ones. In making learning meaningful for learners, one should consider their learning environment, as well as their social and cultural environments. The classroom can be seen as a social system which affords the child an opportunity to interact with more knowledgeable persons and through this interaction, to extend, change knowledge and thinking (Lemke, 2001). The socio-cultural approach reflects Vygotsky's (1978) social constructivist theory of learning, which included the concept of a learner's zone of proximal development (ZPD).

2.2.1 Vygotsky's theory of learning and ZPD

Some Vygotskian writers view ZPD as a 'connecting' concept in Vygotsky's theory, which integrates key elements of his theory (Bruner, 1993; Valsiner, 1988; Moll, 1990; Waiqui, 2006). Vygotsky defined the ZPD as the distance between the real level of development and potential level of development (Blanck, 1990). With the concept of ZPD, Vygotsky (1982) hypothesised that the development process follows the learning process, but the learning will only be developmental if it is processed within the ZPD.

Minick (1987) suggested that the ZPD should be thought of as not simply as a cleverly organised set of activities or tasks to be completed by students, but rather, as a key theoretical construct, capturing as it does the individual within the concrete social situation of learning and development. He further identified three related but distinct phases in the development of Vygotsky's thoughts:

> *The first phase that emphasized sign-mediated activity, focusing primarily on individuals in an experimental setting; second phase concentrated on the development of inter-functional psychological systems and word meaning as a key unit of analysis; and the third phase highlighted the importance of situating individuals within a specific social system of interactions – the concept of ZPD was proposed by Vygotsky within this third phase.* (Minick, 1987, p. 185)

Mediation of learning is the main focus of Vygotskian theory of learning. Simply put, mediation refers to the use of tools to accomplish a certain action. The Vygotskian perspective is that teaching is a social activity involving mediation action which is an interaction between the individual and mediating tools. Vygotsky asserted that children learn to use tools of various kinds, of which many are culturally and historically based. Learning is mediated within the ZPD through language.

Language as a cultural tool is regarded as the most powerful tool humans use to mediate their connection to the world, and to one another. Asoko and Scott (2006) highlighted the importance of language in science learning, particularly opportunities in the science classroom to learn how to talk about natural phenomena in a scientific way. Harlen (2004) also highlighted the use of speech for reflection and communication, with reflection occurring when learners are sorting out their ideas. This reflection involves listening and expressing ideas in ways that are understandable and allowing for the linking of old ideas with new ones to create bigger ideas. This thinking is imperative to science learning. O'Donoghue (2013, p. 20) echoed this development of ideas: "The higher order skills of debating and deliberating around what is known and making decisions to try out creative ideas toward better ways of doing things are important, to reduce emerging issues and risks. Here application and synthesis are central to any learning journey." O'Donoghue is saying here that allowing learners to engage in debates and discussions could lead to higher order skills development. This higher order skills development is what we need to promote in our classrooms to achieve quality teaching and learning.

Prominent scholars in education (Russell & Osborne, 1993; Lemke, 2001; Setati & Adler, 2001; Black & Harrison, 2004; Webb, 2007; O'Donoghue, 2013) see value in the classroom discussion, where learners feel they can reveal their current understanding and be helped to confirm understanding. They suggest that these discussions are an essential 'ingredient' to making formative assessment successful. One of the advantages of encouraging peer discussion is that it allows learners to discuss ideas with one another and to check ideas before revealing a group answer to the whole class. This can offer useful reassurance and it can be less threatening if an answer is wrong but is offered as a group response. While individualism is important, collaborative or cooperative learning is encouraged in a social classroom, because it provides opportunities for small group activities where learners can freely share their views about the concept at hand amongst themselves. The teacher also has the opportunity to interact with the group of learners and thus could interact with individual learners within the group.

Lemke (2001) asserts that science education requires learners to talk and write the language of science in order to meaningfully engage in a range of sub-cultural science activities like scientific investigations and all other scientific process skills. The importance of talk in a

science classroom is linked to the development of a setting in which opportunities for formative assessment can occur. Dialogue is a vital part of the process of collaborative knowledge construction. Through dialogue, several formative assessment opportunities arise, as described in Hargreaves:

> *Ideas are proffered, group members assess them in open dialogue and in doing so the person proffering receives immediate feedback that moves their thinking forward (they learn). More than this, in a cascade of similar learning events, new knowledge is constructed by the group.* (2007, p. 3)

Keogh and Naylor (2007) are also key proponents of the notion that science lessons should be environments where learners are willing to consider alternative ideas, justify their opinions and base their decisions on evidence and reasoning. Evans (2001) suggested that there should be more use of the oral response mode in all types of assessment, rather than written or drawn responses, particularly for younger learners whose oral skills are generally more advanced than their written ones.

Dialogue in the classroom thus offers teachers and learners the opportunity to formatively assess understanding. If learners are working silently, their ideas are not being assessed, challenged or receiving feedback, but through talk this can change. However, dialogue poses a challenge to second language speakers (both teachers and learners) in a Natural Sciences class. The learners' discussions are particularly important when one addresses issues such as those pertaining to the environment and sustainability in the class. This is why this study is particularly pertinent to environmental learning and to inferring the Fundisa for Change programme as introduced in Chapter 1, Section 1.2.2.

Classroom 'talks' or dialogues are highly valued in science and can also play a vital part in the process of teasing out misconceptions. Rosenberg, O'Donoghue and Olvitt, (2008) have suggested one way of constructing a coherent learning experience is to build in opportunities for encounter, dialogue and reflection processes. Opportunities for learners to gain skills of assessing their contributions against set criteria of success (self-peer assessments) can also be a useful strategy.

Having been privileged to visit many primary school classrooms in and around the Western Cape, my personal observation is that learners are rarely helped to engage in classroom discussions or collaborative work. Group-work activities are set up, but teachers in most of

the classrooms I visited do not give their learners guidance on how to 'talk' about what they are doing in class in a way that help them make sense of things they are supposed to be learning (Mercer, Wegerift & Dawes, 1999). Webb (2007) suggested that teachers need to be skilled at facilitating classroom discussion for them to be skilful guides.

The ZPD can be seen as an area of dialogue and of interaction for teacher-learner and learner-learner, in which the teacher can support learners by using different formative assessment techniques. It is because of this context, that it seemed worthwhile in this study to investigate how the Natural Sciences teachers mediate learning through implementation of formative strategies when teaching science concepts. The concept of scaffolding which is related to the concept of ZPD is also used in this study to look at how teachers used the teaching and learning activities and tasks to support student learning.

2.2.2 Scaffolding

In the area of building and construction, scaffolding is a temporal structure used to support a working crew and materials to be used in construction, maintenance and repair of buildings, bridges and other structures. In education, the idea of scaffolding originated from the work of Bruner who defined scaffolding as:

> *A process of setting up the situation to make the child's entry easy and successful and then gradually pullback and handing the role to the child as he [sic] becomes skilled enough to manage it.* (1993, p. 60)

Scaffolding, as a metaphor used in teaching and learning, offers the relevant description of how teachers provide successive levels of temporary support that help learners reach higher levels of comprehension and skill acquisition that they would not be able to achieve without assistance. Scaffolding refers to a variety of instructional techniques used to move learners progressively toward stronger understanding and, ultimately, greater independence in the learning process. According to Larson and Marsh (2006), a teacher can create activities in the classroom to promote learning that is outside the developmental level of his/her learners and provide any necessary scaffolding (help) to broaden the development. Like physical scaffolding, the supportive strategies are incrementally removed when they are no longer needed, and the teacher gradually shifts more responsibility over the learning process to the learners.

Scaffolding learning comes in various forms, like drills and practice prompts, asking a series of build-up questions that help learners to retrieve relevant information, classroom dialogue, providing tips and processes that are necessary for independent problem solving (Tharp & Gallimore, 1988; Shepard, 2005). Another important form of scaffolding can be in the form of support from a teacher and peers (other learners). According to Herrington, Oliver, and Reeves (2003), this teacher/peer scaffolding is important in supporting the reluctant learner and those who are not driven to persevere. One of the main goals of scaffolding is to reduce the negative emotions and self-perceptions that learners may experience when they get frustrated, intimidated, or discouraged when attempting a difficult task without the assistance, direction, or understanding they need to complete it.

Shabani, Khatibi and Ebadi (2010) viewed scaffolding as a joint effort between the teacher and the learner with the hope of transforming the learning environment such that knowledge is shared and facilitated by the knowledgeable person (teacher) so that the learner takes responsibility for his/her learning. Edwards' (2014) proposal of task sequencing or content structuring and representation could help both teachers and learners to navigate the ZPD. Learners in the process could develop the necessary skills and take control of their learning and achieve personal growth. Learner collaboration is what characterises the social context and social interactions within the ZPD. Collaborative interactions in small groups provides an opportunity for learners to share ideas and assume ownership of their own learning, driven by their curiosity rather than teacher prescription, which has been found to be more effective for learning than individual or competitive approaches (Johnson, Maruyama, Johnson, Nelson & Skon, 1981; Okebukola & Ogunniyi, 1984). Wylie and Lyon (2013) argued that collaboration within the classroom provides a supportive environment.

2.3 Assessment

Assessment is a necessary part of teaching and learning. In 1993, a new international journal of assessment in education, '*Assessment in Education: Principles, Policy and Practice'* was launched. The aim of the *Assessment in Education* journal was to provide a forum for scholarly discussion on issues of *principle, policy and practices*, as the journal's sub-title suggests. Whilst there were already in existence several long-established international journals dealing with many technical aspects of testing, there was no journal that focused more broadly on the policy and practice of assessment around the world. According to

Broadfoot and Black (2004), the lack of a dedicated voice for disseminating the substantial volume of international research in the field of assessment was a significant omission. They argued that this omission reflected a barrier to the development of greater understanding and insight concerning the different impact of different forms of assessment on educational policy and practice and about the ways in which both might be developed better to meet their intended purposes.

In their review of the first ten years of *Assessment in Education* journal, Broadfoot and Black (2004) highlighted the four most challenging and cutting-edge aspects of assessment research at the time. The four topics were: the different purposes of assessment and the tension between them; international issues in assessment; quality concerns; and assessment for learning. What is of interest for this study is the last-mentioned topic, that is, formative assessment, which cannot be considered without looking at the previous three aspects of assessments. In the following couple of paragraphs, assessment is defined and an argument for exploring formative assessment through sociocultural theory (rather than other theories of assessment) is presented.

Like Scriven (1967), Taras (2005) defined 'assessment' as single process judgement which could be justified according to specific weighted goals, yielding either comparative or numerical ratings. For Scriven, it was necessary to justify, firstly, "the data-gathering instrument or criteria"; secondly, "weightings and thirdly, selection of goals" (Scriven, 1967, p. 40). Taras (2005) argued for a fourth layer of justifying judgement against the stated goals and criteria.

In his seminal paper, Scriven stated that assessment is a single process:

> *Evaluation in itself a methodological activity which is essentially similar whether we are trying to evaluate coffee machines or teaching machines, plans for a house or plans for a curriculum.* (Scriven, 1967, p. 40)

Scriven (1967) used 'evaluation' in the sense of 'assessment' as posing judgement of learner's work. Even though Scriven was working in the context of curriculum evaluation, the principles he discussed are universally relevant to all assessments. In this study, 'assessment' is considered the process by which teachers and learners make judgement about the level of skills including scientific process skills (Taras, 2005), to measure improvement

over time, to evaluate strengths and weaknesses of the students, to rank them for selection or exclusion, or to motivate them (Wojtczk, 2002).

Since the process of assessment is, as Scriven noted, a single process, that is, making a judgement according to standards, goals and criteria, all assessments follow the same process. Regarding what components make up assessment, Marshal (2005) stated that all assessments include gathering and interpreting information about a student's performance to determine his/her mastery toward pre-determined learning objectives or standards. Despite differences in types or forms of assessment, they all involve three things: gathering information, making a judgement about it, and using that information for some purpose (such as assigning grades, informing teaching, and learning).

Assessment in general falls into three types, which differ in many ways: purpose, timing and how the stakeholders (including learners) use it. The three types could be categorised into:

- diagnostic – where the teacher gathers data to plan for teaching (Stiggins & Chappuis, 2005; Wiggins & McTighe, 2005; South Africa. DBE, 2011b);
- formative assessment/ informal assessment – where the teacher and the learner gathers data in order to adjust the teaching and learning plan (Scriven, 1967; Blooms, Hasting and Madaus, 1971; Isaacson, 1999; Hayes et al., 2005; Leahy, Lyon, Thompson & Wiliam 2005; Taras, 2005 and Black & Wiliam 2009); and
- summative or formal assessment – where the teacher gathers data for promotion purposes (Scriven, 1967; Isaacson, 1999; Hayes et al., 2005; Black & Wiliam, 2009; Wylie & Lyon, 2013).

Assessment (formal or informal) results are utilised in the education system, both by the administrators and teachers to help make sound decisions regarding student learning and learner promotion (Fook & Sidhu, 2010; South Africa. DBE, 2011d). What is also clear when looking at the above-mentioned purposes of different forms of assessments is that assessment is as important as teaching and therefore its quality influences the quality of learning (Hayes et al., 2005). Some experts argue that assessment activities are not secondary to teaching and should receive equal attention (Wiggins, 1998; Fook & Sidhu, 2010). Leahy et al. (2005) concurred with this view and emphasised the promotion of 'minute by minute' formative

assessment where teachers are formatively assessing learners' understanding as they move forward with their teaching.

Improving content of assessment is important but not sufficient to ensure that assessment will be used to enhance learning (Shepard, 2000). This study is looking at classroom practices and what opportunities are presented by the teachers in integrating classroom assessment as part of the learning process. Sadler (1998, p. 80) wrote about "the long-term exposure of students to defective patterns of formative assessment". According to Perrenoud (1991, p. 92) "every teacher who wants to practice formative assessment must reconstruct the teaching contract so as to counteract the habits acquired by his pupils".

Having idealised the envisaged classroom like most researchers in the field of formative assessment, Shepard (2000) acknowledged that the challenges that come with changing the classroom culture is a daunting task. Teachers will need help in learning to use assessment in new ways. They will need a theory of motivation and a sense of how to develop a classroom culture with learning at its centre (Shepard, 2000).

2.3.1 Assessment in the South African curriculum

In this section, the account of assessment developments in South Africa is contextualised within a brief historical review of education post-1994, with particular attention to formative assessment. As was presented in Chapter 1 (Section 1.1), post-1994 the teaching approach adopted in South Africa was that of outcomes-based education (OBE), with Curriculum 2005 being the curriculum approach developed for South Africa. Van der Horst and McDonald described the South African OBE approach as:

> *A learner-centred, results-oriented approach to learning based on the beliefs or assumptions that all learners must be granted the opportunity to reach their full potential; that the learning environment should create a culture of learning, and that all stakeholders involved must be cooperating partners.* (2003, pp. 5-6)

The process of learning in OBE was considered as important as the content. By spelling out the outcomes to be achieved at the end of the process, both the process and the content of education are emphasised. The prescribed learning outcomes were intended to encourage a learner-centred and activity-based approach to education (South Africa. DoE, 2002). This learner-centred approach called for a 'shift' from a teacher-centred approach (Chisholm,

2000) where the teacher's role was to facilitate and mediate new content knowledge. Dada et al. (2009) noted that, during group work, learners were left alone to construct their own knowledge.

Alongside curriculum content developments has been much activity towards formulating a national policy on assessment in South African schools. A number of initial documents were drafted along the way (see South Africa. DoE, 1997, 1998, 2001). The Draft Assessment Policy document stated that a 'paradigm shift' was needed in assessment practices in South Africa. This shift is characterised as a 'move from the judgmental to the developmental role of assessment' (South Africa. DoE, 1998). The shift led to the introduction of 'Continuous' assessment (abbreviated in the document as CASS) which was seen as the vehicle through which this 'paradigm shift' would be achieved. In the document, different methods of collecting assessment evidence were proposed: "CASS should not be interpreted merely as being the accumulation of a series of traditional test results" (South Africa. DoE, 1998, p. 8).

The document stated that: "in an outcomes-based education assessment has to be linked to the critical outcomes and the specific outcomes of the eight new learning areas of Curriculum 2005 and has to be integral to teaching and learning" (South Africa. DoE, 1998, p. 7). The document also stated that assessment has to value teachers' judgements. The document was not clear, however, as to what extent teachers would be able to use their own professional judgements in assessing learners within the stipulated parameters – range of outcomes, 'assessment criteria', 'range statements' and 'performance indicators'. The final version of the new Assessment Policy document stipulated clearly how teachers should go about assessing the specific outcomes of various learning areas. The document stated that "assessment must provide a clear indication about how well outcome is being taught and learned. Learners must show evidence; of progressing towards achieving the outcomes" (South Africa. DoE, 1998, p. 7).

As evidence of learning, teachers have to compile a portfolio (cumulative evidence of achievement) for each learner. When the learner is promoted to the next grade, s/he moves with her/his portfolio, which should include samples of learners' work. The assessment policy aspiration with respect to portfolios met with critiques. It was reported by Dada et al. (2009, p. 34) that the "focus on learner portfolios at the GET Band is problematic because keeping learners' assessment evidence of learning in a file means that learners do not receive

their assessment tasks and so do not get feedback and learn from the assessment experience". The portfolio requirement seemed to be based on a desire to increase the use of assessment for diagnostic and formative purposes. However, teachers were challenged by the shift from using test or examination results as evidence of learner achievement to collecting different piece of learners' work as evidence of achievement (Lubisi & Murphy, 2002).

The other significant feature of C2005 was lesson planning integration across learning outcomes and across learning areas. This called for skilled teachers who would be able to integrate learning outcomes and pay attention to the subject pedagogical demands. However, in the case of environmental learning, lesson planning integration and a cross-curricular approach was problematic for teachers. In practice, the focus on cross-cutting themes tended to detract from furthering the "aims of the learning area" and "deepening of knowledge and/or process skills specific learning areas" (Lotz-Sisitka & Raven, 2001, p. 61). The challenge was not only learning outcome and cross-curricular integration practices, but teachers also experienced difficulties with their own unfamiliarity with environmental concepts that were new in the curriculum (Lotz-Sisitka, 2009). The unfamiliar environmental concept concern was consistent with environmental education research reports, for example, Schudel (2010) reported that teachers experienced difficulties with finding and contextualising relevant content knowledge.

Learning outcomes and cross-curricular integration had implications for assessment practices. By implication, teachers were expected to plan and implement assessment strategies that would enable teachers to assess their learners against the set outcomes. In South Africa, environmental educators working with C2005 reported that teachers had difficulties with selecting and adapting activities that made appropriate links with learning outcomes and assessment standards. Teachers also had challenges in designing assessment activities that would enable them to judge how well knowledge, skills, attitudes and values had been met (Schudel, 2006; Ncula, 2007; Mambinja, 2008).

C2005 emphasised continuous and criterion-referenced assessment where mastery of learning was competence-based (Spady, 1994). The 'shift' from norm-reference, where learners are compared (for example, IQ tests and entrance tests) to a criterion-reference assessment was a significant action regarding assessment in the curriculum. Criterion-reference assessment

occurs when learners are measured against defined (and objective) criteria. It is often, but not always, used to establish a learner's competence (whether s/he can do something).

2.3.2 Assessment in the Revised National Curriculum Statement

The revision of C2005 led to the introduction of the Revised National Curriculum Statement (R-NCS) which was completed in 2002 and implemented in 2004. New Subject Frameworks and Subject Assessment Guidelines were introduced. The frameworks and guidelines clearly outlined how to plan for teaching as well how to assess. Although the R-NCS stipulated the content to be taught and the assessment standards, it lacked clarity on what teachers were required to teach from grade to grade (South Africa. DoE, 2009).

One of the areas that is constantly criticised through all the South African curriculum reforms is assessment. The critiques include policy conceptualisation, quality of assessment and implementation of proposed assessment tasks (Motala, 2001; Nakabugo & Sieböger, 2001; Pryor & Lubisi, 2002; Vandeyar & Killen, 2007; Dada, et al., 2009; Stear & Gopal, 2010; Taylor, 2013). Some of the issues of assessment were also addressed in the 2009 final report on curriculum review presented to the Minister of Basic Education, Angie Motshekga. Some of these issues were:

> *Clarity, overload, the number and nature of assessment tasks, recording and reporting requirements, promotion and progression, and the issue of the General Education and Training Certificate (GETC) and the exit examination for Grade 9 learners; forms of assessment that lack a range of strategies; focus on learner portfolios at the GET Band is problematic because keeping learners' assessment evidence of learning in a file means that learners do not receive their assessment tasks and so do not get feedback and learn from the assessment experience*. (Dada et al., 2009, p. 31)

The recommendations regarding the above-mentioned criticisms were:

> *To discontinue the learner portfolios thereby reducing the load of learners' work. The recommendation was to keep the learners' work on their books or files and be available when needed for external evaluation; to specify clear and simple assessment guidelines specific to each subject; to incorporate a range of forms assessment. Formal examinations and tests, as well as projects and research are required to develop and evaluate a range of skills that learners require for further learning; to develop critical and creative student learning also through memorization of content, concepts and skills for tests and examinations*. (Dada, et al., 2009, p. 37)

The curriculum review led to the introduction of the Curriculum and Assessment Policy Statement (CAPS) which explicitly outlined assessment requirements and the content knowledge to be taught in each grade (South Africa. DBE, 2011b). Although CAPS has streamlined content, concepts and skills progression as mentioned above, it lacks prescribed methods teachers can use in mediation of their lessons. According to CAPS, "educators have the freedom to expand concepts and to design and organise learning experiences according to their own local circumstances" (South Africa. DBE, 2011b, p. 16).

2.3.3 Assessment in the CAPS

In Chapter 1, Section 1.1, the CAPS was introduced. The key changes of the CAPS were that the curriculum was no longer framed in terms of learning outcomes and assessment standards. CAPS was geared to address curriculum coverage and pacing which was a problem in the previous curricula especially in the lower performing schools. Every subject, including Natural Sciences, in each phase has single, comprehensive, concise CAPS that provides details on what teachers ought to teach and assess as stipulated in policy (South Africa. DBE, 2011a). CAPS has a strong emphasis on content knowledge as a basis for learning. What influenced the notion of strengthening content knowledge was the national review (Dada et al., 2009, p. 47) which recommended that the "key dimension related to the successful implementation of curriculum relates to the detail and clarity provided by policy in relation to what to teach".

In introducing the CAPS, the South African Minister of Education, Mrs Motshekga, shared with the public the reasons of focusing on content knowledge and specified assessment within the curriculum: "The intention is to streamline the curriculum documents into single documents for each Grade and each subject in which content and assessment are specified" (Motshekga, 2010, p. 6). According to the Natural Sciences CAPS, the topics in each knowledge strand "should not be studied separately or independently" and "it is very important to help learners to recognise the links between related topics so that they acquire a thorough understanding of the nature and interconnectedness of life" (South Africa. DBE, 2011b, p. 10). In the Natural Sciences, for example, issues of environmental learning appear in all four strands, that is, Life and Living; Matter and Materials; Energy and Change and Planet Earth and Beyond. Teachers, therefore, are encouraged to look for the links between

related issues and find ways to teach and assess learners so that they can acquire deeper understanding. Dreyfus, Wals and van Weelie (1999) caution educational systems when dealing with environmental education and said: “it is not sufficient to take a piecemeal approach by attempting to integrate the various parts of and components of environmental education in different school subjects or science disciplines.” This is because environmental education is multi-disciplinary in the sense that it focuses on nature, environment and society as interdependent and inseparable entities (Dreyfus, Wals & van Weelie, 1999). They further argued that following the route of a fragmented approach weakens the disciplinary knowledge, awareness and skills to be developed in these subjects or disciplines.

The curriculum demands on integration of ideas, skills and concepts within and across the grades has implications not only for content delivery but also for assessment (formative and summative). In the CAPS-Natural Sciences much of environmental learning has been developed with the traditional attitude-behaviour models in mind (Fishbein & Ajzen, 1980). According to attitude-behaviour models, people need to be supplied with a considerable amount of information about the state of environment. This information will lead to an increase in environmental awareness which is an important pre-requisite for changing one’s environmental behaviour. However, there is a growing body of research that shows that these models represent an oversimplification of reality and incorrectly assume a linear correlation between knowledge, awareness and behavioural change (Dreyfus et al., 1999). What this means is that providing information is not enough to change people’s behaviour. But what is important how people learn: “What do they want to know and learn? What knowledge and skills should not be kept from them in their attempts to give shape and meaning to their own lives”? (Dreyfus et al., 1999, p. 160). Content coverage does not encourage learners to take action in solving problems arising from uncompliant activities, for example, building houses that are not energy-efficient. Learning about cause and effect only does not engage learners fully with the full body of knowledge regarding environmental issues; instead it presents the complex nature of environmental learning in a simplistic way.

The CAPS-Natural Sciences also encourages teachers to have freedom to expand concepts and to design and organise learning experiences according to their own local circumstances (South Africa. DBE, 2011b). This poses a challenge to those teachers that lack content knowledge and pedagogical content knowledge (including knowledge of assessment) as Schudel reported: “teachers experience difficulties in finding relevant content knowledge”

(2010, p. 113). The reason for focusing on formative assessment in this study is to explore formative assessment strategies used by teachers to support student learning when engaging with Natural Sciences concepts. As mentioned above, CAPS encourages an "active and critical approach to learning instead of rote learning which does not create opportunities for critiquing of given truths" (South Africa. DBE, 2011b, p. 4). Taking, for example, a topic like biodiversity, learners need to engage in real environmental threats and problems, and look for real solutions to these challenges (authentic learning).

Authentic learning calls for authentic assessment strategies. For assessment to be authentic, Wiggins (1989, 1998) recognised four distinguishing characteristics: i) tasks should stimulate real life challenges; ii) the criteria for evaluation should be transparent so that learners can be properly guided; iii) self-evaluation should be an integral part of the task; and iv) the final output should be presented to real audience.

Other researchers in the field of assessment, for example, Newmann and his associates, Herrington and his co-workers also shared the views on what authentic assessment should look like. Newmann and his associates' criteria for authentic assessment includes: i) Learners need to produce their own knowledge (knowledge construction) as opposed to conventional means of assessment where learners are often encouraged to reproduce information (Newmann, Secada & Wehlage, 1995; Duinen, 2006). ii) Disciplinary enquiry, where learners are challenged to demonstrate deep understanding of key concepts of a particular discipline. iii) The third criterion matches Wiggin's fourth characteristic of authentic assessment, that learners should be involved and convince the audience. What is central to this characteristic is that learners produce an output that has "personal value" (Newmann et al., 1995).

Based on a broad survey of literature, Herrington and his co-workers (2003) drew up a long list of standards of authentic assessment with a special focus on online learning. These included:

i) have value beyond the classroom because it allows learners to recognise multiple interpretations; it gives learners the opportunity to explore different possibilities and examines the tasks from different point of view.

ii) authentic online assessment requires plenty of time, unlike the conventional forms of assessment it cannot be administered in few minutes or few hours. It encourages

collaboration between the learner and the teacher or amongst peers. It also promotes self-reflection to enable learners to move towards better choices and it is not contained in one specific area but rather requires learners to integrate learning across disciplines.

Herrington's views assessment authenticity as resting on production of something that will represent the totality of what learners gained from teaching experience. Unlike the traditional closed-ended forms of assessments, authentic assessment is designed to produce diverse outcomes.

In all the above accounts, one can deduce that these authors have common premises regarding the features of authentic assessment. Firstly, the authors agreed that for assessment to be authentic, it should replicate real life challenges in which learners need to be immersed. This means that authentic tasks should go beyond assessing learners' competence in recalling and memorizing facts and simple application of mathematical equations. If authentic environmental learning helps learners to understand the interactions of environmental, social and economic processes and cope better with the complexity of sustainable development, the above-mentioned characteristics should be incorporated for assessment to be authentic and support teaching and learning.

The second common aspect is that the task learners engage with must be meaningful to them to boost their interest and thus increase engagement. The third aspect that is common between Newmann and Wiggins is that learners should share their work so that it can be tested (Wiggins, 1989). Wiggins saw this a true measure of performance where learners could present their work and be able to defend their views and also be able to change them when convinced by their peers. The last common aspect between Herrington and Wiggins is including self-assessment and self-reflection in the design of the task for assessment to be authentic. In reflecting on their work, learners can gauge how much they have learned and how much is unlearned. The reflection can inform them to make better choices and be able to think of a strategy in order to gain the expertise expected of them after completing the subject (Fook & Sidhu, 2010).

Taking into account the complexities of environmental learning, demands of authentic assessments, learners should be provided with sufficient and appropriate support through

classroom teaching. Formative assessment strategies include most, if not all, the features presented above.

2.3.4 Assessment in the CAPS Natural Sciences

The CAPS-Natural Sciences document gives the general definition of assessment as:

> *A continuous planned process of identifying, gathering, interpreting and diagnosing information about the performance of learners. All forms of assessment involve generating and collecting evidence of achievement; evaluating this evidence and using this information to understand and thereby assist the learner's development and the teaching process. Assessment should be both informal (Assessment for Learning) and formal (Assessment of Learning). In both cases, regular feedback should be provided to learners to enhance the learning experience.* (South Africa. DBE, 2011b, p. 85)

The two types of assessments discussed in the CAPS-Natural Sciences are formal or summative assessments and formative assessments (South Africa. DBE, 2011b). Examples suggested for formal or summative assessments in the CAPS-Natural Sciences include projects, oral presentations, demonstrations, performances, tests, examinations and practical work. According to the CAPS-Natural Sciences document, the informal or formative assessments are geared to serve the purpose of preparing learners for summative assessment: "Informal assessment (formative assessment) task, means building towards formal assessment and teachers should not only focus on the formal assessment" (South Africa. DBE, 2011b, p. 5). For the purpose of this study, the terms formative and summative assessments will be used and a more detailed description of both terms will be addressed in Section 2.4.

In the CAPS policy document, there is a focus on formal assessment practices that are clearly defined for each subject. The Natural Sciences framework outlines which topics and concepts are to be taught and suggests activities and the practical guidelines for what needs to be assessed. For formal assessment, the CAPS-Natural Sciences (Senior Phase) prescribes eight school-based assessments per term and two examinations as outlined in Table 2.1 below.

Table 2.1: Formal assessment requirements for Natural Sciences Grade 7 - 9

Formal assessments	Term 1	Term 2	Term 3	Term 4	Total % for the year
School-based	Test 1 Practical task 1 (investigation)	Test 2 Practical task 2 (investigation)	Test 3 Practical task 3 (investigation)	Project Practical task 4 (investigation)	**40**
Examinations		Exam 1 on the work from terms 1 and 2		Exam 2 on the work from terms 3 and 4	**60**
Number of formal assessments	**2**	**3**	**2**	**3**	**100%**

The teachers are expected to plan for assessment, including for formative assessment as they prepare for classroom teaching (South Africa. DBE, 2011 d). The planned teaching activities and formal tasks should cater for a range of cognitive levels and abilities of learners within the teaching and learning context. Table 2.2 below shows the expectations for proportionate emphasis on different cognitive levels when designing the assessment activities/tasks.

Table 2.2: Cognitive levels for the assessment of content in Grades 7, 8 and 9

Setting tests and tasks for different cognitive levels	**Knowing science**	**Understanding science**	**Applying scientific knowledge**	**Evaluating, analysing and synthesising scientific knowledge**
Percentages indicating the proportion of low, middle and high order questions in tasks, tests and exams	**Lower order questions** **40 %**	**Middle order questions** **45 %**		**Higher order questions** **15 %**
Useful verbs to use when setting questions	State Name Label List Define Describe And others …	Explain Compare Rearrange Illustrate Give examples Calculate Make generalisation And others …	Predict Apply Use knowledge to: Demonstrate Solve Implement Judge And others …	Select Differentiate Analyse Infer Suggest a reason Discuss Categorise And others …

2.3.5 Implementing formative assessment in the South African classrooms

South African research suggests that South African teachers need to be better educated to teach the curriculum effectively, and that a large number of teachers in the country have insufficient content knowledge and limited effective teaching strategies (Fleisch, 2008). Kuze and Shumba (2011), in their study of feedback, highlighted that teachers are not effectively trained nor fully equipped on how to give learner feedback which is one of the key strategies for effective formative assessment practice. This challenge of undertrained teachers was noted by Fakudze (2004, p. 277): "teachers, especially in the non-Western settings, need pre-service and in-service programmes with instructional strategies to help them present science in a way that takes into account the learners' social and cultural background". By implication, poor teacher pedagogical content knowledge has a negative impact on assessment pedagogical knowledge. Shepard (2000) acknowledged the difficulties teachers would have when faced with new changes in the curriculum. He argued that teachers will not only need help in implementing the content but also with "learning to use assessment in new ways" (Shepard, 2000, p. 12).

According to Black (1998), teaching and formative assessment are indivisible. He argued that effective teaching begins with planning activities that elicit evidence of learning, that is, activities should be justified in terms of learning aims that they serve. This suggests that formative assessment is important to all learning. In the CAPS-Natural Sciences document, formative assessment is described as a daily monitoring of learners' progress and it further stipulates how formative assessment can be done through observation, discussion, practical demonstrations, informal classroom interactions, classwork, investigations, and so on. Self-assessment and peer-assessment are part of informal assessment and allow active involvement of learners in assessment with teachers playing an overseeing role. This is important as it allows learners to learn from and reflect on their own performance (Black & Harrison, 2004; Leahy et al., 2005; Black & Wiliam, 2009; South Africa. DBE, 2011b). All these are important formative assessment practices. However, in the South African classrooms they do not receive equal attention compared to the formal assessment strategies, by both the teachers and administrators (Kuze et al., 2011).

The second principle of the CAPS encourages an "active and critical approach to learning instead of rote learning which does not create opportunities for critiquing of given truths" (South Africa. DBE, 2011b, p. 4). The Fundisa for Change Programme (2013) interpreted

active learning as the learning that requires learners to engage actively with complex social and ecological concepts, issues and risks relating to local and global contexts. Putting the learners at the centre of teaching and learning and creating opportunities for the learners to acquire diverse skills, means that active strategies should be used. Dreyfus et al. (1999) argued that when learners are involved in the learning process, this builds a strong foundation for them to take action and be active citizens. This pedagogical perspective should enable learners to critique and evaluate content, concepts and issues introduced to them.

Putting learners at the centre of teaching is important as they are working with Natural Sciences content knowledge which is in some cases multi-disciplinary, complex and contested. Learners need to engage critically with these complex issues. For teachers to be able to support student learning, they "need to develop the capacity to design teaching and learning interactions that encourage critical thinking and analysis of topics at different scales and in different contexts" (Fundisa for Change, 2013, p. 11). In this section, the classroom implications in this regard are also presented. Having said that, however, it is still evident in most South African classrooms that I happened to work in, that teachers dominate the activities of the classroom. There is minimal or no meaningful discussion taking place, and minimal or no feedback given to the learners regarding their progress in relation to the set learning goals (Kuze & Shumba, 2011).

Both classroom discussion and feedback are key to formative assessment and, implemented correctly, could address the posed challenges that are facing the South African basic education system. Attesting to this, Hoardley (2007), comparing two different South African mathematics classroom contexts (working class classrooms with four middle class classrooms), found that in the former context, teachers tended to focus on everyday knowledge as opposed to principles and procedure. She also pointed out the lack of or little feedback given to learners pertaining their mistakes.

2.4 Formative assessment

A substantial review of formative assessment conducted by Black and Wiliam (1998a, 1998b) outlined the purpose and the utility of formative assessment. In their review, they argued that formative assessment used properly could raise classroom standards. They

claimed that formative assessment is effective in promoting student learning across a wide range of educational settings, that is, disciplinary areas, types of outcomes and levels. They also acknowledged that formative assessment is more complex than it seems. This means that formative assessment is far more complex than attaching a grade on a piece of learner's work or giving compliments on how well or badly a learner has performed on a certain piece of work. Also worth mentioning is that this complexity increases when we deal with more complex issues or content such as deliberating on environmental issues.

Blooms et al. make the following distinction between formative assessment and summative assessment:

> *Summative assessment is concerned about determining the extent to which the learner has achieved curricular objectives or goals. In this case if the learner passes or fails a task, for example, test. Formative assessment, on the other hand is concerned about helping the learner to do well in relation to the set objectives.* (1971, p. 274)

Having outlined this distinction, some researchers in this field (for example, Black and Harrison, 2004; Hayes et al., 2005; Leahy et al., 2005; Black & Wiliam 2009; Harris, Irving & Peterson, 2009) have observed that the distinction between formative assessment and summative assessment is not as sharp as it is described above. The teacher at any point can deliberately design assessment tasks which serve both purposes of formative and summative assessments. For example, the teacher may give learners a project that they submit in stages or drafts. After each draft, the teacher gives learners feedback (with no mark or grades attached) on how well they have done the project, fulfilling a formative purpose. Finally, the teacher will mark the project and assign marks or a grade and this grade will count toward a summative assessment score.

The focus of this research is on the implementation of effective formative assessment. In this section, the following aspects are discussed:

- Working definition of formative assessment,
- Leahy et al.'s (2005) five 'key strategies' of formative assessment,
- Wylie and Lyon (2013) 'Ten dimensions of formative assessment'.

2.4.1 Working definition of formative assessment

As noted above, formative assessment is a concept that is more complex than it might appear

at first sight. In this study, I have adopted a definition of formative assessment proposed by Wylie and Lyon (2013, p. 7): "Formative assessment is a process used by teachers and learners during teaching that provides feedback to adjust ongoing teaching and learning to improve students' achievement of intended instructional outcomes".

I have chosen this definition over the one proposed by the Department of Basic Education because the focus is not only on what the teachers are doing during the process but the learner also plays an important role in the process. Throughout this study 'formative assessment' is used to mean what the teachers and learners do with the evidence they have gathered to promote learning.

2.4.2 Formative assessment practices

According to Heritage (2007), in order for the teachers to use formative assessment correctly, they need to optimize their knowledge in their subject domain, pedagogical content knowledge, and knowledge of learners' prior learning. These skills are key characteristics on mastery-level teaching, but in many ways they are expectations of effective and quality formative assessment practices. Teachers have skills to collect evidence, use it and draw inferences but fail to plan for the 'next step' (Heritage, 2009). To plan on how to assist learners move forward in their learning is key to the formative assessment process.

Leahy et al. (2005) proposed a model of conceptualising formative assessment classroom practices. Their five 'key strategies' of formative assessment are outlined in Table 2.3 below. The five strategies give teachers a range of approaches they could work on and they acknowledge they could be used for any kind of assessment not only for formative assessment practices. The teacher could choose one or more strategies to work on. For example, the teacher in a lesson could focus on clarifying goals or criteria for success.

Table 2.3: Aspects of formative assessment adapted from Leahy, Lyon, Thompson and Wiliam (2005)

<table>
<tr><th colspan="4">Where the learner is going? Where the learner is right now? How to get there?</th></tr>
<tr><td>Teacher</td><td rowspan="3">1
Clarifying intentions and sharing learning intentions and criteria for success

Understand and sharing learning intentions and criteria for success

Understand learning intentions and criteria for success</td><td>2
Facilitating effective classroom discussions, activities and tasks that elicit evidence of learning</td><td>3
Providing feedback that move learners forward</td></tr>
<tr><td>Peer</td><td colspan="2">4
Activating learners as teaching resources for one another (Learners helping each other to learn)</td></tr>
<tr><td>Learner</td><td colspan="2">5
Activating learners as the owners of their learning</td></tr>
</table>

Wiliam (2014) suggested three approaches regarding formative assessment: i) the five ‘key strategies’ of formative assessment strategies define the territory of formative assessment; ii) teachers need to choose a suitable technique for implementing the practice; and, iii) teachers should adapt techniques to make them work in their context.

According to the Leahy et al. (2005) model, the five “key” strategies presented in Table 2.3 above operate across three processes – *where the learner is going, where the learner is right now* and *how to get there*. It is not only teachers that need to observe these processes, but the learners are also involved. Learners need to understand where they are going and the intentions of learning the concept. What do they know and understand about the topic or concept at hand? Most importantly, they need to pay careful attention to the criteria for success which will help them to get where they are supposed to be at the end of the lesson.

Wylie and Lyon (2013) noted a parallel process between student learning and teacher professional learning in terms of implementing formative assessment. They argued that improving teachers’ formative assessment practice is an ongoing cyclic process that involves

teachers asking the same questions – Where am I headed? Where am I now? How do I close the gap? They presented this in a cyclic model as shown in Figure 2.1 below.

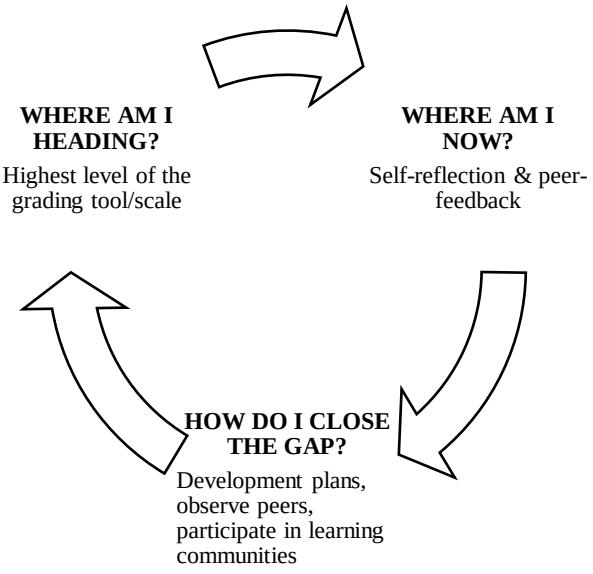

Figure 2.1: Teacher professional learning during formative assessment processes (adapted from Wylie and Lyon, 2013, p. 3)

There are various formative assessment techniques that can be used by teachers as tools for checking learner understanding. For example, Dodge (2009) presented about 25 techniques that teachers could use in their classrooms. Table 2.5 below presents some examples of these techniques. As indicated in the table, in the column on how to carry on the activities, the technique could be used to assess an individual learner, group of learners or the whole class. Using a range of these techniques over the course of a week, for example, a teacher could get a sense or a more accurate picture of what learners know and understand. The teacher could obtain a "multiple-measure assessment 'window' into student understanding" (Ainsworth & Viegut, 2006, p.10).

Table 2.4: Formative assessment techniques

Techniques to Check for Understanding	**Processing Activities**
Index Card/Summaries/Questions	Periodically, distribute index cards and ask students to write on both sides, with these instructions: Side 1: Based on our study of (unit topic), list a big idea that you understand and word it as a summary statement. Side 2: Identify something about (unit topic) that you do not yet fully understand and word it as a statement or question.
Hand Signals	Ask students to display a designated hand signal to indicate their understanding of a specific concept, principal, or process: I understand_____ and can explain it (e.g., thumbs up). I do not yet understand _____ (e.g., thumbs down). I'm not completely sure about _____ (e.g., wave hand).
Misconception Check	Present students with common or predictable misconceptions about a designated concept, principle, or process. Ask them whether they agree or disagree and explain why. The misconception check can also be presented in the form of a multiple-choice or true-false quiz.
Observation	Walk around the classroom and observe students as they work to check for learning. Strategies include: anecdotal records; checklists; discussion
Three-Minute Pause	The Three-Minute Pause provides a chance for students to stop, reflect on the concepts and ideas that have just been introduced, make connections to prior knowledge or experience, and seek clarification. • I changed my attitude about …. • I became more aware of … • I was surprised about … • …
Exit Card	Exit cards are written student responses to questions posed at the end of a class or learning activity or at the end of a day.
Choral Response	In response to a cue, all students respond verbally at the same time. The response can be either to answer a question or to repeat something the teacher has said.
One Sentence Summary	Students are asked to write a summary sentence that answers the "who, what where, when, why, how" questions about the topic.

The third approach suggested by Wiliam above is that teachers need to adapt these techniques to suit their context. Adapting the techniques to suit one's context creates ownership for both learners and teachers. Wiliam (2014) argued that the techniques employed should be

grounded in deep cognitive principles about learning, and that they should be relevant to teachers' practices and feasible for implementation.

Harlen and Qualter (2009) noted the usefulness of thinking about what the learners and the teachers do when engaging in formative assessments as a cycle of events. It is this kind of interactive process that distinguishes formative assessments from any other kind of assessment. They viewed learners at the centre of the cycle because of the central role they play in the formative assessment process.

> *Every action the teacher takes during the process involves interaction with learners and learners interacting with the teacher. The teacher gathers evidence about the learners' achievements, interprets it and uses the evidence to help them to make the next instructional decision, that is, in informing pedagogical moves.* (Harlen & Qualter, 2009, p. 170)

Learners as active participants in the formative assessment process can also act on their own behalf. That is, when learners know the goals of teaching and learning, they give the teacher evidence about their own understanding in relation to the set goals. The more the learners can take the role of self-assessment, the more they can move toward being able to decide their next step. What is not highlighted or lacking though in the cycle is the collaboration among learners as proposed by some Vygotskian theorists (for example, Cole, 1996).

In his theory of learning, Wittrock (1974) emphasised one very significant and basic assumption: "The learner is not a passive recipient of information, rather she/he is an active participant in the learning process, working to construct meaningful understanding of information found in the learning environment" (p.182). According to Wittrock (1990), in order for the learners to make meaning, they create relationships among or between their memory and new information. He further emphasised that learners should be accountable and responsible for learning and should be mentally active in constructing those relationships.

2.4.3 Ten dimensions of formative assessment

Looking at the five 'key' strategies of formative assessment presented in Section 2.4.2 above, for formative assessment to be effective both teacher and learner need to be actively involved. Wylie and Lyon (2013), expanding on their definition, highlighted five attributes of effective formative assessment:

- *Learning progression – should clearly articulate the sub-goals of the goal.*
- *Learning goals and criteria for success – should be clearly identified and communicated to learners.*
- *Descriptive feedback – learners should be provided with evidence-based feedback that is linked to the intended teaching and learning outcomes and criteria for success.*
- *Self- and peer-assessments – both self- and peer-assessments are important for providing learners opportunity to think meta-cognitively about their learning.*
- *Collaboration – a classroom culture in which teachers and learners are partners in learning should be established.* (2013, p. 7)

Wylie and Lyon (2013), using the Leahy et al. (2005) model, identified 'ten dimensions' of formative assessment practices that could be observed during a lesson, as shown in Table 2.5 below. They see these dimensions as areas that could bring out the hidden integrations of formative practices. Hence, they argued: "Focusing on just a single dimension likely would not result in a robust implementation of formative assessment. Rather an integrated approach is required" (Wylie & Lyon, 2013, p. 12).

Below, brief descriptions of each dimension of formative assessment practices are presented. The descriptions highlight specific aspects of learner involvement and engagement with formative assessments across the 'ten dimensions'. In some cases, the dimension may directly focus on the learner's role in the formative assessment process (for example, peer assessment, self-assessment). In other cases, the degree to which learners are involved may be minimal as compared to the teacher's role (for example, in the clarifying goals and criteria of success). What is also significant across all dimensions is the role of the teacher to facilitate the process such that the learners are deeply engaged at all levels and take ownership of their learning.

Table 2.5: Ten dimensions of formative assessment and five "key" strategies adapted from Wylie and Lyon (2013) and Leahy et al. (2005)

Dimension	Statement	Strategy
I	Clarifying goals/learning intentions	1
II	Sharing criteria for success	
III	Tasks and activities that elicit evidence of student learning	2
IV	Questioning strategies that elicit evidence of student learning	
V	Feedback process during questioning	3
VI	Descriptive feedback	
VII	Peer-assessment	4
VIII	Self-assessment	5
IX	Collaboration	
X	Use of evidence to inform teaching and learning	

2.4.3.1 Dimension 1: Clarifying goals

The focus of this dimension is on the teacher's presentation of the learning goals/objectives. Teachers need to clarify the goals and write them in a language that is accessible to the learner (Wylie & Lyon, 2013). Stating the learning goals/objectives helps the learners to know the purpose of the lesson. Referring to the learning goals/objectives also helps them to make connections between the various aspects in a lesson and know how these pieces support their deep conceptual understanding of the learning intentions. To achieve this, the teacher should make multiple meaningful and appropriate verbal references to the learning goals/objectives throughout the lesson in ways that support student learning, or summarise progress toward the goals at the end of the lesson.

Teachers need to explain to the learners, lesson goals they set out for them. According to Jones and Jones (2009) having two-way communications between teacher and learners is the best way to unlock the learners' full potential to learn and ultimately achieve the set goals. She further argued that involving learners in the process of clarifying goals, helps them to take charge of their learning. For example, the teacher could ask learners to explain the goals to other learners and in the process, assess themselves in relation to the set goals. Setting goals for the term or a week is important, but what was suggested by Wylie and Lyon (2013) is the importance of learner understanding of the lesson goals and why they have to achieve them (Jones & Jones, 2009).

2.4.3.2 Dimension 2: Clarifying criteria for success

The focus of this dimension is on how the teacher identifies the criteria for success for a particular lesson and explicitly shares this with his/her learners. Formative assessment begins when teachers share achievement target with learners, presenting those expectations in learner-friendly language accompanied by exemplary learners' work (Stiggins, 2007). Criteria for success should be clearly identified and communicated to learners so that learners know what is expected of them. This communicates quality. What is communicated to learners depends on the nature of the task. Rubrics, checklists, model answers, memoranda are all useful tools. Research suggests that when learners understand what quality work looks like, they can be able to demonstrate their own learning (Leahy et al., 2005; Wylie & Lyon, 2013). When the criteria for success are integrated into the lesson, this makes it easier for the learners to access it and that could promote the learner quality of work.

The classroom environment should allow the learners to ask questions for clarification, test the criteria in class, and assess one another's performance against the criteria (Wylie & Lyon, 2013). This can promote student learning. For the learners to meaningfully use and apply the criteria for success, they need to be involved in one way or another in the process. In order for them to reach the highest level of criteria, they must meaningfully use and apply the criteria of success.

Frederiksen and Collins (1989) used the term 'transparency' to express the idea that learners must have a clear understanding of the criteria by which their work will be assessed. As Shepard (2000, p. 11) suggested: "features of excellent performance should be so transparent that learners can learn to evaluate their own work in the same way their teachers would". According to Frederiksen and Collins (1989, p. 30) "assessment systems should provide a basis for developing a metacognitive awareness of what are important characteristics of good problem solving, good writing, good experimentation, and good historical analysis and so on".

Wiggins (1989), supporting Frederiksen and Collins, argued that such assessments can address not only the product that one is trying to achieve, but also the process of achieving it, that is, the habits of the mind that contribute to successful learning and development of skills. Shepard (2000, p. 11) viewed this process as a basis for fairness: "knowing the rules by

which you will be judged". Agreeing with Wolf and Reardon (1996), 'making thinking visible' and making excellence attainable, brings out a more fundamental sense of fairness.

2.4.3.3 Dimension 3: Tasks and activities that elicit evidence of student learning

This dimension focuses on the things or activities that the learners are engaged in, excluding classroom discussions. Here the learners need to show that they have learnt something through being engaged in those activities or tasks (Wylie & Lyon, 2013, p. 33).

Koch (2005) cautioned teachers not to simply give learners activities which they may enjoy and have lots of fun in using the materials. She said "An activity is not a lesson. A lesson is composed of concepts that as a teacher you plan for your learner to develop." (p. 259). She further suggested that the process of learners performing the activity and the teacher reflecting on it may be considered the essence of a lesson (Koch, 2005). Edwards (2014), in her 'quadrant' model of task sequencing, outlined the sequence which the teachers could follow for promoting student learning. She described the model as:

> *an attempt to point to the advantages of taking time to enable learners to both acquire and use, i.e., internalise and externalise, the substantive and syntactic knowledge of the subject-based curriculum; while also developing higher order thinking and taking control over their own learning through tasks given in quadrants 2 and 3*. (2014, p. 7)

2.4.3.4 Dimension 4: Questioning strategies that elicit evidence of student learning

The focus here is, firstly, on the key questions the teacher plans to ask the learners and, secondly, on how the teacher orchestrates classroom discussion in order to collect evidence of learning. The questions should be those that will encourage learners to use certain cognitive, process skills or dispositions. Asking 'closed' questions that learners will respond with 'yes' or 'no' or by raising their hands for understanding are common and familiar techniques that almost all teachers have used. However, these techniques should be analysed for frequency and effectiveness in terms of supplying useful evidence of learner understanding.

The quality and pacing of questioning is a skill that teachers need to practise regularly. All teachers, at all levels, need to be able to craft and create questions that encourage learners to

think, to learn and make connections. Questions that require learners to respond with complex answers, like asking them to explain their answers; can be a better view into learners' thinking and their ability to move forward to solve subsequent problems. Responses to such questions could also provide evidence of metacognition and can help teachers to elicit evidence of student learning (Erickson, 2007). Curiosity, asking questions throughout life, is a strong human trait. How we find out and solve problems is key and hence, teachers are encouraged to use this curiosity so that learners could keep on raising questions in the classroom.

According to Ramsey and Duffy (2016) effective questioning and using 'wait' time by skilled teachers elicit evidence of learning from learners. The effectiveness of questioning during teacher-learner interactions can be significantly enhanced by a few basic techniques:

- *Posing a question before asking learners to respond. By doing this allows all learners to prepare themselves to answer the question. This encourages the full class participation.*
- *Allowing enough 'thinking time' by waiting at least 7 – 10 seconds before expecting learners to respond. During this 'wait time' the teacher can repeat, or rephrase the question*
- *Making sure that all learners are given opportunity to respond rather than always relying on volunteers* (Ramsey & Duffy, 2016)

Setting and asking these questions is not enough. It is only through paying careful attention to learners' responses and allowing them to ask their questions in relation to what they are engaged with, that the teacher could collect evidence of learning (Wylie & Lyon, 2013).

2.4.3.5 Dimension 5: Feedback loops during questioning

This dimension focuses on the teacher providing ongoing feedback that will help learners to develop the science ideas and content. As mentioned in the previous dimension, through classroom discussions, teachers could collect evidence of student learning. It is through these discussions where back-and-forth with the teacher and other learners could extend their thinking and understanding of the content taught (Wylie & Lyon, 2013). This links well to other areas of formative assessment and 'task sequencing' proposed by Edwards (2014) such as the provision of challenging activities to support learners in revealing their ideas and opportunities for peer-discussion and larger group discussion to encourage open dialogue.

The formative assessment dimension of the feedback process informs both the teacher and learners about learner understanding and what can be done to increase knowledge. However, assessment is formative only if both the teacher and learner do something with the feedback to facilitate 'shifting' forward learner understanding within the ZPD so that new challenging activities can be presented that draw on the child's previous experience. Feedback can be used in closing the gap between current learning and intended learning (Wylie & Lyon, 2013).

Effectiveness of feedback is influenced by other external factors such as learning context or classroom context. It is critical for the teachers to intentionally plan how he/she is going to give feedback, and choose appropriate techniques that will work in his/her classroom context. For example, in the case where the classroom has many learners, the teacher could use hand-signals and ask learners to display a designated hand to indicate their understanding.

Black and Harrison (2004) explored the features of effective feedback and these can be summarised as follows. Effective feedback is that which:

> *... should initiate thinking – enabling the learner 'to discuss his or her thoughts' with the teacher or a peer; allows learners to match their own judgement of quality against that of the teacher or peer; may direct learners 'where to go for help and what they can do to improve' their work.* (2004, p. 12-13)

2.4.3.6 Dimension 6: Individualised descriptive feedback (written or oral)

This dimension focuses on the teacher as the provider of feedback. This feedback should be in the relation to the intended outcomes and the criteria for success. Learners in return need to attend and respond to the feedback (Wylie & Lyon, 2013). For example, after marking a piece of work and getting feedback, the learner does corrections or revises his/her work.

The descriptive feedback could be specific to more formal feedback that is given to an individual learner (individualised feedback) and sometimes to a group of learners in the case of group work (group feedback)

2.4.3.7 Dimension 7: Self-assessment

The importance of the self-assessment dimension is to provide learners with an opportunity to reflect on or assess their learning (Wylie & Lyon, 2013). This is an opportunity to think meta-cognitively about their learning. Learners, like teachers, have a role to play in their learning process. As was mentioned in the previous sections, learners are active participants in the process of formative assessment. They therefore should take ownership of their learning. Harlen and Qualter (2004) though, argued that this role when loosely framed as 'self-assessment', loses its meaning and purpose of the focus which should be on the action or work rather than 'self'. In other words, the focus should be on what the learners are doing or/and how they are engaging in formative assessment process. As has been mentioned, it is the learners that are doing the learning; it is they that ultimately should take the actions that will lead to learning.

Self-regulated learning is a key outcome of formative assessment. Self-regulated learning could be defined as a child's capacity to plan, guide, and monitor his/her behaviour within and flexibly according to the changing circumstances (Diaze & Amaya-Williams, 1990). Edwards (2014) argued that if the aim is to develop learners academically, learners need to understand their own learning. Hence in her 'quadrant' model she proposed that teachers scaffold learning from the first quadrant where learners are guided until the third quadrant where they are given opportunity and/or full responsibility to take control of their learning.

In a symposium presentation, Wiliam (2014) proposed: "self-regulated learning can be thought as a key aspect of productive formative assessment, in relation to formative assessment strategies of 'clarifying, sharing and understanding learning intentions and criteria for success' and 'activating students as owners of their learning'". Learner self-assessment, therefore, serves a cognitive development purpose as well increases learners' responsibility for their own learning, thus making the relationship between teachers and learners more collaborative.

According to a Vygotskian perspective on learning, the teachers or knowledgeable persons (peers), have a key role to play in mediating and 'passing on' existing knowledge (such as scientific knowledge) to learners. The role of the teacher in the self-assessment dimension is to make sure that learners are effectively and successfully engaging with the process of self-assessment. This is because it is only when learners are meaningfully engaging with these

processes that learning is taking place. Teachers need to engage learners in tasks where they can take control of what is to be done and how to assess themselves.

2.4.3.8 Dimension 8: Peer assessment

The peer assessment dimension focuses on learners' thinking about other learners' work and the process allows learners to support their peers. Some of the scholars of formative assessment (Black & Wiliam, 2009; Black & Harrison, 2014) saw the role of learners in formative assessment as not only important because they can assess themselves, but that once they can assess their work they can look at their peers' work and give them feedback (peer assessment). Harlen and Qualter (2004) argued that peer-assessment should go beyond simply what we see in many classrooms, where learners are marking each other's test or activity. For Harlen and Qualter (2004), peer-assessment means learners helping each other with their learning, by giving each other feedback and suggesting the next steps to be taken to improve their work.

Research suggests that opportunities to review the work of a peer and to provide feedback are very beneficial to the person providing the feedback, as well as to the person receiving the feedback (Wylie & Lyon, 2013, p. 41). For this to be possible, teachers need to structure the peer-assessment task in a way that supports all learners to assess one another and provide feedback that supports learning. For example, teachers could model the activity for learners, and give them exemplars of feedback. By doing this, peer-assessment can have a positive impact on the quality of all learners' work due to high quality of the feedback and structures put in place for the use of the feedback, that is time to read and revise their work (Wylie & Lyon, 2013, p. 41).

Teachers as observers when learners are doing peer-assessment, should use their professional judgement and take note whether the peer assessment activity is meaningful to learners. According to Wylie and Lyon (2013) teachers as observers may draw on evidence from learner comments about the peer assessment task, the degree to which learners seriously engage with the task, how they appear to view its importance, and if there is follow-through to address any identified deficiencies to make a judgment.

2.4.3.9 Dimension 9: Collaboration

This dimension focuses on classroom culture, on the relationship between teacher and learners and learner-learner interactions. It capitalises on an open learning and teaching environment, where teachers and learners are partners in learning. How the teachers and learners work together toward a common goal is key in this dimension. This common goal is evidenced by clear focus on learning, collaboration, respect and an appreciation of multiple viewpoints (Wylie & Lyon, 2013, p. 15).

Improving the content of assessments is important but not sufficient to ensure that assessment will be used to enhance learning (Shepard, 2000). Shepard suggested that classroom culture needs to change so that learners no longer focus on perform on achieving high scores in test as an end separate from real learning. Creating a learning environment (culture) where learners and teachers would have a shared expectation that finding out what makes sense and what does not is a joint worthwhile exercise, is essential toward taking the next step in learning (Shepard, 2000)

2.4.3.10 Dimension 10: Using evidence to inform teaching and learning

The focus of this dimension is on how the teacher collects and uses evidence to adjust his/her teaching. The teacher gathers evidence from engaging learners and observing them when they are exploring science concepts. Therefore, the evidence can be gathered through learner oral or written work. The dimension is focused on how the teacher capitalises on the opportunities to collect evidence that prevail during teaching. Assessment becomes formative once the teacher and learners use the evidence gathered or feedback to adjust teaching and learning (Exploratorium, 2006).

This study used these dimensions to describe formative assessment processes observed and the constraints or enablers that teachers experienced when implementing formative assessment processes in their classrooms. Having highlighted the complexities and difficulties of implementing formative assessment, not all of the strategies could be observed in one or two lessons. At the same time, these strategies do not take place in isolation, that is, they are intertwined and more than one strategy can be observed in a lesson. What is important is the culture of the classroom where these operations take place.

2.5 Learner conceptual development

From the sociocultural point of view, learning is not transmitted from a more knowledgeable person to the less knowledgeable other, but is actively built up in the sharing cognition process. The active engagement of learners is key in meaning making and it does not only take place in the mind of the learner but also includes aspects of social being, language, interaction with others including teachers and other learners. Changing your mind is not simply a matter of rational decision making; it is a social process with consequences embedded in social setting (Resnick & Klopfer, 1989, p. 8).

Vygotsky's (1978, 1997) ideas that individual cognitive development is embedded in a sociocultural environment that provides tools for thinking and partners (teacher and/or peers) who are skilled in the use of such tools, serves as a source of discussion when looking at how learners learn and how social setting shapes that learning. Watkins and Mortimore (1999) defined learning from a broader perspective as any development that occurs to learners and this development includes cognitive, affective and others. Learning takes place at a construction platform consisting of prior knowledge that forms a foundation. In this sense, learning therefore is an active process of knowledge construction rather than receiving it from a knowledgeable person.

Learners come to school with their own conceptions about what makes the world work. Their minds are full of ideas that they have developed to help them understand the world they live in. These ideas are sufficient and allow them to function, up to a point. Once they get to school they are introduced to ideas that may not necessarily be the same as those they held before. In the schooling system, what is important is to broaden those ideas so as to ensure that learners acquire and apply knowledge and skills in ways that are meaningful to their own lives. The implications for teaching are that teachers, when planning a lesson, need to realise that learners come to class with prior knowledge and through the process of engaging in meaningful activities they construct their personal experiences about the taught idea or concept.

Isaacson (1999) described planning for teaching as one important role played by formative assessment in the teaching and learning process. In order for the learning to be effective, the

role of the teacher is to plan for differentiated learning experiences, content relevance and to find ways of helping learners to link this new knowledge to prior knowledge. These differentiated learning experiences should fall within learners' abilities (Tyler 1949, cited in Shawer, 2006; Shawer, Gilmore & Banks-Joseph, 2008) for teachers to be able to develop their learners' cognition not only at the knowledge level, but also at the skills and capabilities levels. The challenge around learner cognitive development, according to Resnick & Klopfer (1989), is the teacher's competence in teaching content and thinking skills at the same time. They further argued that it is impossible to achieve depth in teaching and learning if content and thinking skills are not equally addressed.

For Resnick and Klopfer (1989) thinking skills are not restricted to some advanced or "higher-order" stage of mental development. They argued that: "thinking skills are intimately involved in successful learning of even elementary levels of reading, mathematics and other subjects" (Resnick & Klopfer, 1989, p. 1). As mentioned above, CAPS is based on the principle of learning that encourages active and critical thinking rather than rote and uncritical learning. This principle applies at all levels and in all subjects in the Department of Basic Education. It appears that the CAPS developers agree with what Resnick and Klopfer are proposing here, that thinking skills development must pervade learners' lives from primary school onward in all subjects. This principle of learning is also in line with the constructivist perspectives of learning which state that learning occurs when individuals are actively involved in the learning process, integrating new knowledge with existing knowledge.

Critical thinking is a higher-order thinking skill, which goes beyond observation of facts and memorisation. Resnick (1987) acknowledged that there are different perspectives on defining higher-order thinking, and mentioned their broader origin. She explained that "philosophers promote critical thinking and logical reasoning skills, developmental psychologies point to metacognition, and cognitive scientists study cognitive strategies and heuristics. Educators advocate training in study skills and problem solving" (Resnick, 1987, p. 4). Resnick (1987) argued that it is difficult to define higher-order thinking but it is easy to recognise when it occurs. Higher-order thinking involves a cluster of elaborate mental activities requiring nuanced judgement and analysis of complex situations according to multiple criteria (Resnick, 1987). What she means here is that critical thinking is criteria-based. These criteria require that one distinguishes between fiction and fact, can synthesize and evaluate

information, clearly communicate the findings, and solve problems. In her description, Resnick, describes higher order thinking as a process where someone attempts to understand or construct meaning and thus develops intellectually. She qualifies this by saying: "Higher order thinking may take different forms, such as, problem-solving; reasoning; integrating and applying knowledge; coming to conclusion independently; or thinking through different perspectives" (Resnick, 1987, p.3).

Studies consistently show that though faculties of education say that critical thinking is important to their instruction (teaching and learning), they have difficulty articulating a clear conception of it and demonstrating how they foster it (Gardner 1995; Paul & Bartell, 1997). The challenge of articulating a clear perception of critical thinking is what Resnick is arguing regarding the definition of critical thinking, that is, the difficulty in defining critical thinking as compared to observing it or witnessing it when it occurs. As a way of describing higher order thinking processes, Resnick suggested the following broad characteristics that can be seen when one is using higher order thinking:

- *Higher order thinking in non-algorithmic. That is, the path of action is not fully specified in advance.*
- *Higher order thinking tends to be complex. The total path is not "visible" (mentally speaking) from any single vantage point.*
- *Higher order thinking always yields multiple solutions, each with costs and benefits, rather than unique solutions.*
- *Higher order thinking involves nuanced judgement and interpretation.*
- *Higher order thinking involves the application of multiple criteria, which sometimes conflict with one another.*
- *Higher order thinking often involves uncertainty. Not everything that bears on the task at hand is known.*
- *Higher order thinking involves self-regulation of the thinking process. We do not recognize higher order thinking in an individual when someone else "calls the plays" at every step.*
- *Higher order thinking involves imposing meaning, finding structure in apparent disorder.*
- *Higher order thinking is effortful. There is considerable mental work involved in the kinds of elaborations and judgements required.* In as much as higher order thinking has always been a major goal of educational systems, studies consistently show that educational institutions have difficulty articulating a clear conception of it and demonstrating how they foster it (Gardner, 1995; Paul & Elder, 1997). Recognising the use of thinking skills calls for the pedagogical approach not only on how to teach but also on how to assess learner understanding and what strategies or methodologies you are going to use as a teacher. How then, do teachers deal with this challenge of helping their learners get started in developing their thinking skills so that they can

learn effectively and independently later on? And, how do they recognize these thinking skills when dealing with overcrowded classrooms?

In the following section a 'New Bloom's Taxonomy' for learning, teaching and assessment is discussed. There are many valuable and sound strategies and/or models to choose from to engage learners in learning. One of these models is Bloom's Taxonomy of Educational Objectives. This Bloom's Taxonomy of Educational Objectives model, developed by Benjamin Bloom in the 1950s, has gone through several modifications. In this study, Dalton's revised taxonomy is used. This taxonomy is based on the work of Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths, and Wittrock (2001). In Dalton's (2003) revised taxonomy, the types of objectives and learning activities, and particularly assessments, and where they fall in the two dimensional taxonomy, are presented.

2.5.1 Taxonomy for learning, teaching and assessment

In education, objectives indicate what we want students to learn. They are "explicit formulations of the ways in which students are expected to be changed by the education process" (Anderson, et al., 2001, p. 12). Objectives are especially important in teaching because teaching is an intentional and reasoned act. The learning environments, activities, and experiences should be aligned with, or be consistent with, the selected objectives (Anderson, et al., 2001). Different scholars refer to objectives differently: Bobbitt (1918) and Rugg (1926a and b, as cited in Anderson, et al., 2001, p. 3) call them aims, purposes, goals and guiding outcomes. Kendall and Marzano (1996) and Glatthorn (1998) (as cited in Anderson, et al., 2001, p. 3) referred to them as content standards or curriculum standards.

In the CAPS-Natural Sciences (South Africa. DoE, 2011b), the objectives of learning are called 'Specific Aims'. The terms carry the same meaning, namely what we want students to learn through teaching. In this study, the term objectives and goals were used to refer to intended student learning outcomes. According to Yore (2003), objective statements are generally insufficient to convey the richness of the meaning wrapped up with them. Polay (1958, cited in Wolf, 1995) suggests that for these objectives to be clear to learners they need to be communicated by examples and not only by stating them and hoping learners will understand them. It is for this reason, Leahy et al., (2005) in level 1 of their model, presented in Table 2.3, emphasise the clarification of learning objectives and criteria for success. The first step in Edwards' (2014) 'task sequencing' model, begins with the teacher modelling

what the learners should be doing, that is, exemplifying the learning expectations in the learning materials and assessing how learners are engaging with the new knowledge. For learning to take place or to say teaching was successful, both learner and teacher need to understand the subject demands.

In Dalton's (2003) taxonomy, objectives are classified in a two-dimensional fashion – cognitive processes and knowledge. The taxonomy table is meant to help teachers and other educators in at least three ways:

> *1) It can help them gain more complete understanding of their objectives (both those they choose for themselves and those that are provided to them by others); that is, the table can help the educators answer what we refer to as the "learning question" (what is important for the learners to learn in the limited school and classroom time available?).*
>
> *2) From this understanding the teachers can use the table to make better decisions about how to teach and assess their students in terms of the objectives; that is, the table can help teachers answer the "teaching question" (How does one plan and deliver content that will result in high levels of learning for large numbers of learners?) and the "assessment question" (How does one select or design assessment instruments and procedures that provide accurate information about how well learners are learning?).*
>
> *3) It can help them determine how well the objectives, assessments, and teaching activities fit together in a meaningful and useful way; that is, the table can help educators to answer the "alignment question" (How does one ensure that the objectives, instruction, and assessment are consistent with one another?).* (Anderson, et al., 2001, pp. 6-10)

Table 2.6 illustrates, in a matrix, how cognitive development can be viewed in terms of how facts, concepts, principles, procedures and metacognitive realisations are being elicited through processes of remembering, understanding, applying, analysing, evaluating and creating. In this study, the taxonomy was used as an analysis tool of the lesson plans by looking at the intentions of objectives, teaching and learning activities, and assessments. The teachers stated the learning objectives during the pre-lesson discussion and during stimulated recall interviews we discussed their perspectives on whether learners had achieved what they intended their them to learn. The detail on how the analysis took place is discussed in Chapter 4 of this study.

Table 2.6: 'New Bloom's Taxonomy' framework (Dalton, 2003)

<table>
<tr><th rowspan="2">The knowledge dimension</th><th colspan="6">The cognitive process dimension</th></tr>
<tr><th>Remember</th><th>Understand</th><th>Apply</th><th>Analyse</th><th>Evaluate</th><th>Create</th></tr>
<tr><td>Fact</td><td>Remember facts</td><td>Understand facts</td><td>Apply facts</td><td rowspan="3">Analyse using Facts, Concepts, Principles and Procedures</td><td rowspan="3">Evaluate using Facts, Concepts, Principles and Procedures</td><td rowspan="3">Create using Facts, Concepts, Principles and Procedures</td></tr>
<tr><td>Concept/ Principle</td><td>Remember Concepts</td><td>Understand concepts</td><td>Apply concepts</td></tr>
<tr><td>Procedures</td><td>Remember Procedures</td><td>Understand procedures</td><td>Apply procedures</td></tr>
<tr><td>Meta-cognitive</td><td>Remember Metacog. Strategies</td><td>Understand Metacog. Strategies</td><td>Apply Metacog. Strategies</td><td>Analyse Metacog. Strategies</td><td>Evaluate Metacog. Strategies</td><td>Create Metacog. Strategies</td></tr>
<tr><td></td><td colspan="2">Knowledge</td><td>Skill</td><td colspan="3">Capability</td></tr>
</table>

2.5.2 Cognitive development

According to Shawer (2006), cognitive development is the change that occurs in the learner's cognitive schema. This change depends on both teaching and learning. In this study, Watkins and Mortimore's (1999, p. 3) definition of teaching is adopted, that is teaching is "any conscious activity by one or more person(s) which is designed to enhance or strengthen learning in another or others". They further defined learning in a broader perspective as any development that occurs to learners and this development includes cognitive, affective and other development (Watkins & Mortimore, 1999).

As discussed in Section 2.5.1 above, learners gain more skills including scientific process skills and widen their knowledge through interaction and socialization with more competent peers. The role of the teacher in order for the learning to be effective is to plan for differentiated learning experiences and content relevance, and to find ways of helping learners to link this new knowledge to prior knowledge. Isaacson (1999) described planning for teaching as one important role played by formative assessment in the teaching and learning process. These differentiated learning experiences should fall within learners' abilities (Tyler 1949, cited in Shawer, 2006b; Shawer, Gilmore & Banks-Joseph, 2008) for teachers to be able to develop their learners' cognition not only at the knowledge level, but also at the skills and capabilities levels.

2.6 Conclusion

The Vygotskian sociocultural framework has been outlined as a suitable tool for providing insight into social interactions in the classroom. The concept of scaffolding within the ZPD was presented and how formative strategies could be used to facilitate learning and thus contribute to 'shift' in learner ZPD. The chapter also explored the South African curriculum reforms regarding assessment in general and in particular, formative assessment. The emphasis was on how teaching and learning activities, used effectively, could promote cognitive development. The insights generated from the literature enabled me to make sense of the data collected which will be discussed in Chapter 5. In the next chapter, the research methodology is discussed.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter begins with a discussion of the research paradigm central to the study. According to Terre-Blanche and Durrheim (1999), a research paradigm is an all-encompassing system of interrelated practices and thinking that defines the nature of enquiry along all these three dimensions, that is ontology, epistemology and methodology. This chapter discusses the philosophical assumptions and also the design strategies underpinning this research study. Common philosophical assumptions are reviewed in the chapter and the interpretive paradigm was identified for the framework of the study.

O'Leary (2004, p. 85) has defined some of the terms to clarify the key distinguishing features of each of the terms:
Methodology: The framework associated with a particular set of paradigmatic assumptions that is used to conduct the research, that is, scientific method, ethnography, action research.
Methods: The techniques used to collect data, that is, interviewing, surveying, participative observation.
Tools: The devices used to help in collecting data, that is, questionnaires, observation checklists, interview schedules.
Methodological design: The plan for conducting the study that includes all the above.

Two other terms are worth defining as they are major dimensions in the research process:
Ontology - *what is the nature of reality?* The Merriam-Webster dictionary defines ontology as: "a particular theory about the nature of being or kinds of things that have existence". Killam (2013, p.7) referred to ontology as: "the researcher's beliefs about the nature of reality." She further explained that philosophically the term refers to the study of our existence and fundamental nature of reality or being.
Epistemology - *what is the nature of knowledge and the relationship between the knower and would-be known?* Epistemology examines the relationship between knowledge and the researcher during discovery (Killan, 2013, p. 8). In other words, epistemology refers to how we come to know what we know.

This chapter describes the research design including a discussion on the qualitative and case study approaches used in the study as well as a discussion of the research participants in the case. Furthermore, data generation techniques and the instruments used to support these are discussed. This is followed by a discussion on data analysis and management. Issues of validity and ethics are also addressed. The chapter ends with reflections on some limitations of the study.

3.2 Research paradigm

The South African Concise Oxford dictionary (2013) defines paradigm as: "a world view underlying the theories and methodology of a scientific subject". In research, the term paradigm can be traced back to its Greek origins where it means 'pattern' (Cohen, Manion & Morrision, 2011) and was first used by Thomas Kuhn to denote a conceptual framework shared amongst researchers to help them with a convenient model for examining solutions. Kuhn (1962, as cited in Cohen et al., 2011, p. 27) defined a paradigm as: "an integrated cluster of substantive concepts, variables and problems attached with corresponding methodological approaches and tools". The term refers to a research culture with a set of beliefs, values and assumptions that the community of researchers have in common regarding the nature and conduct of research.

All research is based on the underlying philosophical assumptions that are captured in the notion of a 'paradigm'. These assumptions inform questions about what constitutes 'valid' research and which research method(s) is/are appropriate for the development of knowledge in a given study. It is therefore important to interrogate these assumptions when conducting and evaluating any research. Understanding philosophical issues in research helps with clarification of the research design which incorporates appropriate decisions about the research approach, methods, types of data, techniques and tools for gathering, analysis and interpretation of data (O'Leary, 2004). Appropriate philosophical positioning of the research process helps the researcher to explore diverse choices thoroughly and creatively and this promotes harmony between all parts of the research structure.

The research paradigm has an impact in the direction of the research and the intended classification of theories. Patton(1990) argued that:

> *Paradigms are also normative, telling the practitioners what to do without the necessity of long existential or epistemological consideration. But it is this aspect of paradigms that constitutes both their strength and their weakness – their strength in that it makes action possible, their weakness in that the very reason for action is hidden in the unquestioned assumptions of their paradigm.* (p. 37)

To stay focused and on track and not be overwhelmed by many ideas to choose from in the process of research design, a researcher needs to be knowledgeable of the diversity of ideas embodied in different paradigms (O'Leary, 2004). This means that an awareness of different philosophical positions can help to ensure consistency and unity between different elements of research design (O'Leary, 2004).

3.3 An interpretive study

The intention of this study was to understand how teachers view and implement formative assessment practices. To achieve this, the study was designed within the interpretive paradigm, a complex term that embraces many research approaches such as phenomenology, ethnography, naturalistic, constructivist, hermeneutic, symbolic interaction and micro-ethnographic approaches (Denzin & Lincoln, 1994; Easterby-Smith et al., 1994). These interpretive paradigm approaches however share a similar objective, to "understand and interpret social structures as well as the meanings people give to the phenomena" (Cantrell, 1993, p. 83).

An interpretive research study is a social study in which the research looks at the phenomenon in its context. Interpretive researchers believe that reality consists of people's subjective experiences of the external world; thus they may adopt an inter-subjective epistemology and ontological belief that reality is socially constructed. The interpretive research strategy is underpinned by observations and interpretation of observations making meaning of the information by drawing inferences or judging the match between the information and some abstract patterns (Aikenhead, 1997).

This study had features not only of interpretative research. It could also be described as descriptive or naturalistic (Leedy & Ormrod, 2010). The process of observing, reviewing documents and documenting in detail the educational experiences of the cases, positions this research as taking a descriptive approach. The process of documenting observations and all

related activities allowed for ‘thick narrative description’ of the complexities of the classroom interactions. The study took the form of words rather than numbers. It used analytical description rather than statistical generalisation (Robson, 2002). This study could also be characterised as a naturalistic enquiry (Patton, 2002) as the observations were done in real classrooms – the context of this study. Frey, Botan and Kreps (1999) described a naturalistic approach as an investigation of the nature of certain situations, settings, processes, relationships, systems or people to enable the researcher to gain new insights into the phenomenon under investigation.

3.4 Qualitative study

This research study adopted a qualitative design. The aim of this study was to understand and give meaning to human action(s) around formative assessment and it relies mainly on text-based data rather than numerical data. Bloomberg points out that qualitative research is “pragmatic, interpretive, and grounded in people’s lived experiences” (ibid., p. 118). In a qualitative research process, the researcher’s role is to understand multiple realities from the perspectives of the participants.

In selecting a research methodology, Guba (1981, p. 78) suggested that: “it is proper to select that paradigm whose assumptions are best met by a phenomenon being investigated”. Many scholars (Denzin & Lincoln, 2003; O’Leary, 2004; Van Rensburg & Smit, 2004) have argued that human learning is best researched by using qualitative data. This study was about human learning and the effective use of formative assessment strategies to promote learning. The purpose of this study was to explore, without manipulation, the process of learning in a Natural Sciences classroom real life setting, with a view to interpreting the phenomena in terms of meaning attached to them by individual teachers. The focus was on teachers’ perspectives, experiences and challenges regarding formative assessment practices and how they implemented formative assessment strategies to support learning in their classrooms.

Qualitative approaches can account for classroom complexity and reveal classroom interactions amongst learners and teacher-learner interactions. When the understanding of an event is a description of the process that characterises the event, qualitative approaches are better suited than quantitative approaches because they provide insight necessary to

understand the participants' input and role in the event and their perspectives of the experience. Bloomberg (2012, p.118) argued that "qualitative research is grounded in an essentially constructivist philosophical position, in a sense that it is concerned with how the complexities of the socio-cultural world are experienced, interpreted and understood in a particular context". Sarantakos (2013) viewed constructivism and interpretivism as the main theoretical foundations of qualitative methodology and this is strengthened by Bloomberg's (2012, p. 28) assertion that reality is socially, culturally and historically constructed. Another advantage of qualitative research is the flexibility it permits. Silverman (2011) was of the view that the real strength of qualitative research is that it can use naturally occurring data to find the sequences in which participants' meanings are organised. The flexibility that it offers is that the researchers could modify their field research design at any time and as often as they like. The tools use by a field researcher can be relatively inexpensive – one researcher with a notebook and pen can be enough.

Qualitative researchers are primarily concerned with practice, that is, they focus on the process that is occurring. The focus is on participants' perceptions and experiences and the way they make sense of their lives (Creswell, 2012). Qualitative research typically involves fieldwork in which the researcher observes and records behaviour and events in their natural setting. It allows the researcher to go physically to the people in order to observe their natural behaviour which is greatly influenced by time and space (Silverman, 2011). A final advantage of this qualitative study was that it allowed the inductive analysis of data and enhanced the possibility for some kind of subjectivity which would have been lost if quantitative or experimental strategies were applied.

3.5 Case study

This study is a case study that explores the phenomenon of formative assessment in its real life context. Yin (2003) described a case study as a comprehensive research strategy, which covers the logic of design, data generation techniques and specific approaches to data analysis. This case study can be specifically described as using an interpretive case study design in line with the discussion on interpretivism above. A case study is one of several ways of doing research in social science or any socially related context because its aim is to understand human beings in a social context by interpreting their actions as individuals, groups of individuals, communities or events. According to Cohen, Manion and Morrison

(2011), a case study presents a unique example of real people in a real situation, affording readers an opportunity to look at the ideas presented more clearly. This means a case study favours the generation of data in natural settings as discussed in Section 3.3.

According to O'Leary (2004, p. 115), a case study "examines a 'bounded system' where a researcher draws on multiple sources of data generated in the setting". The use of different data generation instruments (interviews, observations, document analysis) enables the researcher to explore the issue under investigation from different lenses allowing glimpses into multiple facets of the phenomenon (Baxter & Jack, 2008). This is also useful as a validation technique (see Section 3.10). In a case study, all data is collated to arrive at the best possible responses to the research question(s). As a result of this, a researcher gains a deeper understanding of why instances occurred as they did, and what might become interesting or important to look at in future research.

Given the interpretive position adopted in this study and the nature of the research questions, the case study methodology was considered the most appropriate approach because it would provide a systemic way of collecting data, analysing data, and reporting the results, allowing greater depth in understanding the situation. The other reason for using a case study methodology in this study was because of its advantage of revealing the unique perspectives and concerns of participants in a real-world (classroom/school) situation (Cohen et al., 2011). These would have been lost or not fairly represented through quantitative or experimental approaches.

The case study design is particularly well suited to situations where it is very difficult to separate a phenomenon's variables from its context (Yin, 2003). Examining the context and other complexities related to the study are essential in understanding the case. The 'how' part of the research questions could not be answered without the context – the teachers' classrooms were the true picture of how teachers implement formative assessment strategies to support quality learning.

3.6 Research participants

The participants in this study were in-service primary school and secondary school teachers enrolled for a two-year part-time Continuing Professional Teacher Development programme

- Advanced Certificate in Teaching (ACT): Senior Phase Natural Sciences programme in the University of Cape Town (UCT). The programme was intended to broaden and/or upgrade teachers' subject teaching and professional competences. The targeted teachers for this programme were those who were qualified at Relative Education Qualification Value (REQV) level 13. This could include the following: Matric + 3 year diploma, National Professional Diploma in Education (NPDE) or an equivalent teaching qualification or higher. Teachers may present a professional Bachelor's in Education (B.Ed) or an Advanced Diploma in Education (ACE) or a former Postgraduate Certificate in Education (PGCE) or a Higher Diploma in Education (HDE). In addition, teachers were required to have either experience of teaching Natural Sciences or have a science qualification at third-year college level.

The ACT programme was offered on request by the Western Cape Education Department and/or National Department of Education. The selection of qualifying teachers to enrol for the ACT programme was done by the Western Cape Education Department and teachers received funding either from the National Education Department or the Western Cape Education Department depending on which department requested the running of the programme. However, the institution (UCT) allowed individual teachers who wished to enrol and pay for the tuition to do so. The institution also sought funding from external funders to support the self-funded teachers. At the time of this study, the Advanced Certificate in teaching programme was in its first year and not all the courses were fully developed including the Natural Sciences Practicum: Senior Phase course.

Selection of research participants and their contexts is critical because it has implications for data generation. This study applied purposive sampling. According to Creswell and Plano-Clark (2011), purposive sampling is when a researcher intentionally selects or recruits the participants. It is the most common sampling strategy in qualitative research and seeks cases rich in information where issues of central importance to the research can be studied in great detail. Of seventeen teachers enrolled for the ACT: Senior Phase Natural Sciences programme, seven were selected to represent teacher demographics. The teachers were teaching in the four Metropole Education Districts (Central, East, South and North) in the Western Cape. These participants were chosen with the hope that they would reflect and provide a diverse and complex picture of teachers' perspectives regarding formative assessment classroom practices. As Patton(2002) put it: "Any common patterns that emerge

from great variation are of particular interest and value in capturing the core experience and central, shared dimensions of a setting or phenomenon". Table 3.1 below presents characteristics of all seven teachers that were involved in this study. All of them were Natural Sciences teachers at Intermediate and Senior Phase levels. Their teaching experience ranged from four years to 21 years.

Of the seven teachers, two were selected for lesson observations. The two teachers were both teaching in culturally diverse schools. The small number was suitable for the research questions and the scope which were designed to accommodate accessibility, time and financial factors involved in school visits (Creswell & Plano-Clark, 2011; Creswell, 2012). The scope of the research was also consistent with the qualitative nature of the study, which according to Cohen et al.'s (2011) advice, researchers need to work with in-depth, smaller scale rather than larger scale data sets. These two cases presented a reasonable platform and enough 'rich' data to describe formative assessment of the two participants.

The two schools where the teachers were selected for lessons observations were easily accessible in terms of proximity to my residential and work place. These schools were also selected because of the good relationships the teachers had with their school principals, which made it easy to approach them. Both school principals accepted the request of observing the teachers in their classroom for research purposes. Time spent in both schools was manageable in terms of my other work responsibilities and sufficient to collect data from these teachers' classrooms without disturbing their daily school routines.

School visits for the purpose of observing lessons was one of the requirements of one of the courses in the ACT: Senior Phase Natural Sciences programme – Natural Sciences Practicum: Senior Phase. The Natural Sciences Practicum course was scheduled for the second year of the programme and at the time of this study the course teaching materials were not yet developed. One of the requirements of the Natural Sciences Practicum: Senior Phase course was to visit teachers in their schools twice a year and observe them teaching Natural Sciences lessons. For this research's purpose the two teachers were visited three times for in-depth data on a smaller scale. Both teachers were chosen because they had potential to assist in producing a rich output (Creswell, 2012).

The first teacher was given the pseudonym Mr Tall. Mr Tall's tertiary training included a Bachelor of Education Honours (B. Ed. Hon). He was the youngest of the group and had four

years of teaching experience (see Table 3.1 below). At the time of the lesson observations, he was teaching at Greyton Primary (pseudonym) school that could accommodate approximately 800 learners from Grade R to Grade 7. The average school fee per learner was R650.00 per year. It was considered an English school because it offered English as the Language of Learning and Teaching. Approximately 80% of the learners enrolled in Greyton primary school were Afrikaans speakers and the other 10% constituted a mix of English and isiXhosa speakers. Mr Tall taught Grade 6 Mathematics, Grade 5 Natural Sciences and English.

Mrs Nyoka (pseudonym), with a Bachelor's in Education (B.Ed) and 32-years teaching experience, had the most experience of the group (see Table 3.1). Mrs Nyoka was teaching at Thembalethu Primary School (pseudonym) that could accommodate approximately 1,750 learners from Grade 1 to Grade 7. The average monthly school fee per learner was R114. 00 and Afrikaans was the Language of Learning and Teaching. Approximately 90% of the learners enrolled in Thembalethu Primary were Afrikaans speakers and the other 10% constituted a mix of English, isiXhosa and other African language speakers. Mrs Nyoka taught Grade 7 Natural Sciences, English and Life Orientation. She was also involved in extra-mural sport or activities – boys under-14 hockey, swimming and the Eskom EXPO for young scientists (science fair). Mrs Nyoka's Grade 7 class comprised 15 boys and 11 girls, of which there were 23 English, one Afrikaans, one isiXhosa and one Shona speaker.

Table 3.1: Teacher profile demographics

Characteristics	**Number (out of 7)**
Age group: 20 – 29	1
30 – 39	2
40 – 49	3
> 50	1
Grade currently teaching: Intermediate Phase (Grades 4-6)	3
Senior Phase (Grades 7-9)	4
Number of years teaching: 1 – 5	1
6 – 10	
11 – 15	2
16 – 20	3
> 21	1
Length of service in the current school: 1 – 5	1
6 – 10	4
11 – 15	2

3.7 Data generation techniques and instruments

The data was generated from three different qualitative data generation techniques. The purpose of using these various data generation techniques was to gather 'rich' data to help with revealing complexities and informing an understanding of the issues under investigation, as well as for validation of claims made at the end of the investigation. The term 'rich data' as explained by Marx explains that "qualitative data and their subsequent representations in text should reveal the complexities and richness of what is being studied" (2008, p. 213).

The three different techniques used were**:**

- **Semi-structured interviews** using an open-ended interview protocol;
- **Lesson observations** using a classroom observation tool, video or audio recorder and stimulated recall interviews to enhance lesson observation data; and
- **Document analysis** of lesson plans, teaching and learning activities and assessment task worksheets.

Each of these data generation techniques is discussed in detail below.

3.7.1 Semi-structured interviews

According to Walford (1991), in social sciences studies, interviews are used as the primary source of data generation. Interviewing allows participants to share their experiences, attitudes, and beliefs in their own words (Cohen et al., 2011). In this study, a semi-structured interview format was used as the primary source of data generation as it would allow conversational and two-way communication. Pre-designed questions, follow-up questions and new questions that arose during interviews were used as a way of probing further conversation during the stimulated interview sessions. The pre-planned questions allow the interviewer to be consistent with the interviewees so that the same areas are covered with each interviewee. As the interview progresses, the interviewee is given an opportunity to elaborate or provide more relevant information if he/she opts to do so. This type of interview allows flexibility as one can vary the course of the interview based on how participants respond. The open-ended questions enabled probing, rephrasing, explanation and additional questions as the need arose during the interview period (Cohen et al., 2011).

Thirteen open-ended interview questions were used to elicit the views of each of the seven teachers interviewed (see Appendix 1 for interview protocol). Teachers were invited at different times for the interviews that took place in the boardroom at my workplace. The boardroom setting was organised such that teachers could feel safe and not intimidated. They were relaxed, freely answering questions and asking questions for clarity where necessary. The interviews were captured using a digital recorder and transcribed verbatim (see Appendix 2 for a sample). The danger of this semi-structured technique is that the researcher may go off on a tangent or lose focus (Cohen, Manion & Morrison, 2007). It is for that reason that I used pre-designed questions so that I had something to guide me and keep me focused.

The semi-structured interviews addressed Sub-question 1 and part of Sub-question 4. Sub-question 1 is *What are teachers' perspectives, regarding formative assessment in the classroom?* Specifically, the questions asked probed participants' understanding and perspectives of policy directives, rationale and techniques for formative assessment, and how they put these ideas into practice. Sub-question 4 is *What are the factors that hinder the effective implementation of formative assessment practices?* Some semi-structured interview questions probed teachers' challenges pertaining to structure, materials, language of learning and teaching (LOLT) and learner participation regarding formative assessment. All seven teachers were interviewed before the classroom observations.

3.7.2 Classroom observations and stimulated recall interviews

Observation is another method for qualitative data generation. The main objective of using observation is to collect data in a natural setting as first-hand information (Cohen et al., 2011). As noted by Cohen et al., one of the advantages of this method is that the researcher gets an opportunity to generate live data that will enable him/her to look at what is currently taking place. The main aim of doing lesson observations was to get an in-depth understanding of the cases under study and their classroom complexities. As a non-participant observer working with real people in real situations, I was able to have a closer look and gain insight into the educational context. The classroom observations contributed to answering Sub-question 2 of this research study – *What formative assessment strategies and techniques do teachers use in classroom situations?* This question provided insight into how teachers implemented formative assessment with an emphasis on the aspects of formative assessment strategies (see Chapter 2, Table 2.4).

Mr Tall was observed for three lessons that were each 45 minutes long. The second teacher, Mrs Nyoka, was observed for two consecutive 55 minute periods and a later follow-up period of the same length. Cohen et al. (2011) highlighted two principal types of observations in qualitative research, namely, participant observation and non-participant observation. The difference between the two types is that a participant observer engages in observed activities and a non-participant observer is not engaged in the activities. Usually I co-teach with my students (teachers), but in this case, I decided to observe only so as to be able to focus on my role as researcher and to generate as much data as possible within the given time.

The classroom observations were captured using a lesson observation tool (see Appendix 3), a video recorder and an audio recorder for the two teachers respectively. The recording of the lessons enabled capturing most of what happened in class. The lesson observation tool was used when observing lessons in the Natural Sciences Practicum course to capture what happened in the lesson and to give feedback to the teachers. In this study the lesson observation tool was used to fulfil the Natural Sciences Practicum course requirement and also to serve as field notes to contribute to classroom observation data. The observation tool was useful for this study since most pedagogical aspects regarding formative assessment were included in the tool. Aspects such as lesson preparation/plan, teaching, classroom interactions were part of the observations.

A time for a pre-lesson discussion before the first lesson observation and a stimulated recall interview after the last lesson were scheduled. The focus of the pre-lesson discussion was on the overall lesson goals of the topic and the specific goal(s) for each lesson. For the pre-lesson discussions, teachers were encouraged to present their lesson plans. The following questions were asked:

- What is the lesson topic and how does it fit into the larger scheme of things (example, Natural Sciences curriculum, prior and future topics)?
- What are the unit objectives and how were they determined?
- How much time is allocated for the topic? How much time is allocated for the lessons? How much is time allocated for each section of the lesson (e.g. introduction, body and conclusion or consolidation)?
- What materials and equipment were prepared for the lesson?
- What assessment strategies were used to determine learning?

- How will the learners be assessed on what they have learned?
- How will they be informed about their performance?

The stimulated recall interviews focused on how the teachers felt about their lessons, if they had achieved what they set out to achieve and where they could improve. Santagata, Zannoni and Stigler (2007) argued that teaching is a cultural activity and its process could be easily reflected upon when it slows down and is critically analysed. Conducting stimulated recall interviews after watching or listening to some selected sections of the video clip or audio recordings allowed participants to reflect on their teaching process. A selection of sections at the beginning and the end of each lesson enabled each teacher to probe lesson objectives and criteria for success. The focus was specifically on the introduction and consolidation of the lessons with the focus on lesson goals and criteria for success. Interesting sections where teachers mediated learning or missed the opportunity to do so were also selected. For the stimulated recall interviews the following reflection questions were asked:

- What went well?
- What did not go well?
- Did you achieve what you planned to achieve? If no, why?
- What would you change when you have to teach the lesson again?

Initially, the stimulated recall interviews were scheduled to take place after the third classroom observation so that we had enough time to review the recordings and engage in discussion. However, both teacher interviews were very short because teachers could not stay for a longer period of time. Mr Tall had only ten minutes for the stimulated recall session due to other school duties. Mrs Nyoka also had limited time due to extra-mural activities she was involved in. Thus, the discussions were brief and shorter than anticipated and selected clips could not be revisited for further discussion on issues arising. What emerged from the discussions though was useful and was included in the deliberations of this study.

3.7.3 Document review

Document review is one of qualitative research data generation methods in which documents are interpreted by the researcher to give voice and meaning to the assessed topic (Cohen et al., 2011). Bowen (2009) defined document analysis as a systematic procedure for reviewing or evaluating documents. According to O'Leary (2004), document analysis serves as a

primary data source, the same was as data gathered in interviews or observations. She described a document as any source of textual data which could include newspapers or media reports. In this study documents reviewed were lesson plans, learning and teaching activities and the assessment task worksheets.

In this study documents reviewed were lesson plans including teaching and learning activities and assessment tasks of the two teachers observed. Lesson plans were reviewed to examine whether formative assessment strategies were incorporated or not in the day-to-day teaching process. Teaching and learning activities and assessment tasks were reviewed with the aim of looking at how teachers thought about developing their learners' cognitive, and scientific process skills.

3.8 Data management

The technique of organising and arranging data in a systematic fashion is called data organisation (Creswell & Plano-Clark, 2011). The purpose of data organisation is to help the researcher to know the type of data at hand and to know where to start the analysis (Creswell & Plano-Clark, 2011). This kind of organisation enabled me to access my data in an efficient more way.

In this study, the data was organised according to the data generation sequence, that is, semi-structured interviews, classroom observations including pre-lesson discussions and stimulated recall interviews and document analysis. Data can come from different sources and at various stages of the research process, O'Leary (2004) advised researchers to keep a record of their data as it is collected. She further advised researchers to keep their raw data for a reasonable period of time so that they can trace results back to the original source. For this study. organising and storing the data in Google Drive was useful and provided not only an efficient way to manage data but I could access the data anywhere from Google Drive. The other benefit for organising was to provide an ordered and manageable data set, which could support the main text of the report and provide the report with validity and further possibilities for critical review by others (Lotz, 1996). Table 3.2 below was created to map out how data was organised in this study.

Table 3.2: Data source log

Index code	Data generation method	Number of item	Data description	Date	Appendix
T_n:IQ_n	Semi-structured interviews	Seven teachers	Teachers expressing their perspectives on formative assessment	18/06/15	Appendix 1 & Appendix 2
PrLD:T_n	Pre-lesson discussions	Two teachers	Presentation of their lesson plans T_1	31/08/15	
			T_2	06/04/16	
TRT_n:L_n	Classroom observations	Two teachers	T_1: 'Safety on using electricity'.	31/08/15 to 02/09/15	Appendix 7
			T_2: 'Biodiversity'	06/04/16 and 07/04/16	Appendix 8
SRT_n	Stimulated recall interviews	Two teachers	Teachers reflecting on their teaching T_1	02/09/15	
			T_2	12/04/16	
T_nLP	Lesson plans	Two teachers	One lesson plan, per teacher received	31/03/16 to 06/04/16	Appendix 7 & Appendix 8

To keep the teachers anonymous, a code was assigned to each of them (Creswell, 2005). The teachers were coded as T – teacher; n – number; IQ – interview question; TR – transcript; L_n – line number; SR – stimulated recall interviews and LS – lesson plans. The code (T_n: IQn) that followed each quotation identified the teacher to allow the readers of this study to recognise repeated comments from a particular respondent. The code (TRT_n: L_n) from the lesson transcript follows each quotation from lesson observation transcripts. Quotations from the pre-lesson discussion were PrLD: T_n and the quotations from stimulated recall interviews were coded as SR: T_n.

3.9 Data analysis

Cohen et al. (2011) explained that data analysis involves organising, accounting for and explaining the data. In other words, one needs to organise data to make sense of what is happening and to identify emerging themes. According to Creswell (2012), data analysis is the process of configuring all the information provided by the participants of the study. In

this study analysis was done in several stages at different times. This was because in qualitative research, gathering of data and its analysis proceed simultaneously. Interpretive researchers attempt to drive their data through direct interactions with the phenomenon being studied (Cantrell, 1993). In a qualitative case study, data analysis is an important process of searching for meaning through direct interpretation of what is observed by researchers and as well as what is experienced and reported by the participants.

In this study a four-phase inductive data analysis process was employed to build patterns, categories, and themes from the bottom up by organizing the data into increasingly more abstract units of information (Creswell, 2012). According to Creswell (2012), this inductive process illustrates working back and forth between the themes and the database until the researchers have established a comprehensive set of themes. The inductive approach allows the researcher to identify frequently dominant or significant findings emerging from the raw data. O'Leary (2004) argued that, in qualitative analysis, coding of themes is part of the data interpretation. She described the process using a 'funnel' metaphor, as the raw data is funnelled through discovering (inductive reasoning) and uncovering (deductive reasoning) themes, which are reflectively interpreted. Through this process, meaningful understanding of the phenomenon study can be reached (O'Leary, 2004).

Data analysis Phase I analysed data generated from semi-structured interviews. Analytic Memo 1 was used to organise interview data (see Appendix 4). The organisation of the data was done by using 13 semi-structured interview questions (see Appendix 1). The next step in the analysis of the semi-structured interview data was to take time and carefully read the data to familiarise myself with it. Eight themes emerged.

Phase I addressed part of the research Sub-question 1 and provided insight into teachers' perspectives regarding formative assessment. The last part of Sub-question 1 was looking at challenges regarding formative assessment practices. The teachers' responses directly related and pertinent to the research questions guiding this study were selected and then compared for possible disagreements or combined for conveying similar ideas (Creswell, 2012; Creswell & Plano-Clark, 2011; Coffey & Atkinson, 1996 and Miles & Huberman, 1994). This enabled me to identify themes, patterns and regularities and to make meaning of the data (Cohen et al., 2007). Eight themes were identified, namely formative assessment as: *a way of fulfilling policy directives; means to improve planning; a way of informing teaching; means*

for scaffolding individual learning; a way of preparing individual learners for tests and examinations or for summative assessments; a tool for reporting and learner promotion; a tool to promote learner-learner collaboration; a way of promoting quality learning. These themes are reported in Section 4.2 in the next chapter.

Phase II of the analysis was directed at responding to Sub-question 2 – *What formative assessment strategies and techniques do teachers use in classroom situations?* As mentioned in Chapter 1, Section 1.5, Sub-question 2 was directed at providing insight into what formative strategies were implemented during the lessons. Classroom observations were analysed with respect to 'Ten dimensions of formative assessment' (see Section 2.4, Table 2.5) to explore evidence of teachers' use of formative assessment strategies.

Phase III of the analysis made use of Dalton's 'New Bloom's' taxonomy (see Table 2.6) to gain insight into the role of formative assessment in supporting low, medium and higher order cognitive development. This phase was the document analysis, that is, a review of the lesson plans, teaching and learning activities and assessment tasks. Phase III of analysis was aimed at responding to Sub-question 3 – *How do teachers use teaching and learning activities and assessment tasks to support learner cognitive development and promote quality learning and teaching?* Cognitive development, with respect to the teaching and learning activities and assessment tasks, was recorded in terms of how facts, concepts, principles, procedures and metacognitive realisations were elicited through the process of remembering, understanding, applying, analysing, evaluating and creating as outlined in Dalton's 'New Bloom's' taxonomy (see Section 2.5.2, Table 2.6). Dalton's (2003) framework employed for reviewing lesson plans allowed analysis of the connections or alignment between learning goals, teaching and learning activities and assessment tasks. Anderson et al. (2001) viewed strong alignment between these parts of the learning progression process as an indication of the potential for quality teaching and learning.

Phase IV of the analysis of data was aimed at responding to answer part of Sub-question 4 – *What are the factors that hinder the effective implementation of formative assessment practices?* Phase IV explored challenges teachers experienced regarding implementation of formative assessment. This analysis was done across data sources, that is, across semi-structured interviews, lesson observations and stimulated recall interviews. Challenges teachers experienced during the lessons observed were analysed and reported in this phase.

Table 3.3 below presents a summary of data analysis at all phases and the tools used to present the analysis for each phase.

Table 3.3: A summary of data analysis

Research question: *What are teachers' perspectives, experiences and challenges regarding formative assessment in environmental learning process and how does it contribute to cognitive development in the learning process?*				
Sub-question	**Data**	**Phase of analysis**	**Analytical tools used**	**Section**
1	Semi-structured interviews	I	Analytical memo 1	4.2
2	Classroom observations: Teaching and learning activities and assessment tasks	II		4.3.1 & 4.3.2
3	Document analysis: Teaching and learning activities and assessment task	III	Table 4.2 & 4.3 Table 4.4 & 4.5	4.3.3.1 & 4.3.3.2
4	Cross data: Semi-structured interviews, lesson observations and stimulated recall interviews	IV		4.4

3.10 Validity

Maxwell (1992, p. 121) defined validity as "the correctness or credibility of a description, conclusion, explanation, interpretation, or other sort of account". He argues that validity is a relative concept, which depends on how research conclusions relate to reality – it does not depend on methods used but relies on evidence. What this means therefore, is that, validity is evidence-based.

This study employed four different data generation methods. Examining distinct types of data regarding the same phenomenon enables the researcher to better understand the complexity of what is being studied and increase the credibility and trustworthiness of the data as well as the interpretation of the researcher (Marx, 2008). The process of using a variety of data sources to cross check and verify data is termed triangulation (Cohen et al., 2007). O'Leary (2004, p. 115) described triangulation as: "using more than one source of data to confirm the authenticity of each source". Shenton (2004) highlighted diverse ways in which triangulation could be achieved, for example, observations, focus groups and individual interviews.

Another validity strength in this study was the focus on generating 'rich' data (see Section 3.7). According to Geertz (1994, p. 215), the quality of qualitative research is judged by the thickness of the description presented and how much that description is able to engage the

readers. Comparing the generated data through different techniques (semi-structured interviews, classroom observations, stimulated recall interviews and document analysis) assisted in producing evidence of what happened in the study. The analysis of the lesson plans and the activities and/or tasks used supported the explanations or strengthened the evidence produced.

I employed 'member checking' or respondent validation to ensure that the information from participants was accurately transcribed after the interviews, so that the participants could change the data by adding or removing information as they needed to, thus ensuring that what I had captured in the transcript corresponded with the respondents' experiences. Lincoln and Guba (1985) viewed 'member checking' as a systematic way of getting feedback about one's data and conclusions from the participants you are studying. This is a very important step in clarifying one's own (researcher's) interpretations or understanding of what participants say and do and what perspectives they have on what is going on.

Participants' feedback and their interview responses should be both taken as evidence regarding the validity of the account the researcher is giving (Lincoln & Guba, 1985; Hammersley & Atkinson, 1995). Checks relating to the accuracy of the data may take place "on the spot" in the course, and at the end, of the data generation dialogues. Participants may also be asked to read any transcripts of dialogues in which they have participated (Shenton, 2004). In this study, teachers received the classroom report as part of the UCT course requirement even though the report did not cover all that was discussed in this study. But some of the key aspects, like how the teacher structured and taught the lesson and the classroom engagements and reflections on the lesson were discussed with teachers during the stimulated recall interview session (see Appendix 3 for report form).

3.11 Ethical considerations

Cohen et al. (2011) addressed the concept of ethics as the moral facet of the research which includes procedural ethics as well as ethical practices during the research process. In this study, the process of collecting data started by trying to understand the nature of my responsibilities to the student-teachers by asking myself the question. How am I going to make sure that the student-teachers feel they are in control of and feel comfortable with what

happens to their stories? How can I ensure that this research would allow them to empower themselves?

Ethical considerations were at the forefront of this study and were maintained throughout the project. Special attention was given to access and acceptance, informed consent and beneficence. These are discussed in the sections below.

3.11.1 Access and acceptance

Creswell (2012) claimed it is essential to request permission before using or entering any site. Before beginning my research, I requested permission not only from the teachers but also from the Western Cape Department of Education and the principals of each school. An official letter was written to the Education Department requesting permission to do research in the schools. Permission was granted by the Department of Education (see Appendix 5).

Once I received permission from the Department of Education to access the schools, meetings with principals of the participating schools were scheduled. Both principals were positive about the research and signed informed consent agreements (see Appendix 6a). Consent was also sought from the seven teachers who participated in this research. Teachers were requested to sign a consent form that explained the purpose of the research study, the rights of participants, and a guarantee that pseudonyms would be used (see Appendix 6b). The observations took place during the teachers' actual classroom teaching. Teachers were requested to teach a topic within the scope of normal curriculum delivery, that is, as per Natural Sciences CAPS scheduling. This means that school schedules were never disrupted.

3.11.2 Informed consent

Lewis (2003) sees informed consent as a critical concept in ethical considerations, and thus all participants and affected parties need to have a clear understanding of the purpose of the study. Parties involved may include the funders, the organisation, or individuals conducting the research. Parties should be clear on how the data will be used, and what participation will mean for them. Informed consent to participate was obtained from all the teachers participated in this study (see Appendix 6b). This means they were provided with information about the purpose of the study, how the data would be used, and what participation and time would be required of them.

As mentioned in the previous section, free and informed consent was sought as a way of formalising the verbal agreements between me, teachers and the schools. Signing the informed consent was not taken as a once off agreement but it was a continually negotiated process throughout the research period, making sure that teachers did not feel obliged to continue as per our original agreement. For example, in teacher Nyoka's class after negotiations of capturing classroom activities by recording, we agreed not to use the video recording nor take learner pictures but used an audio recorder. The research participants were given the option to withdraw from the study at any point in time.

3.11.3 Beneficence

In this study I considered the question of beneficence. How were the participants going to benefit from this study? The research findings were shared with care, that is, the data was not treated as simple answers or what transpired in the classrooms, but it was treated as mutually created and constructed by me and the teachers (Piquemal, 2002). Ongoing mutual dialogue was a way of being faithful to the teachers' engagement, so that they could also professionally benefit from the dialogue.

Loyalty to, and respect for, the teachers was maintained throughout the study. One cannot address ethics fully without addressing issues of respect for participants' views and opinions. Piquemal (2002) cautioned researchers to conduct their profession with care, making sure that their research does not harm the participants but they should benefit from it. In this study, the relationship between the researcher and the teachers was reciprocal, that is, both I and the teachers were involved in a relational dialogue in which we shared, gave and received (Piquemal, 2002). This was made possible by the pre-existing relationship that I had with the teachers. This allowed a good relational dialogue.

Through reciprocity, teachers were integrated into a rational dialogue in which they were in control of what they gave and very aware of what they were entitled to. They took interest in the study to such an extent that when I got to their schools to meet with the principals, principals were aware of the research possibilities during their studies and were keen to know if everything was going all right.

An ethic of care was a driver of this study. It felt important to me to be of help to teachers enrolled in the programme. The importance of this help went beyond any importance attached to the qualification that might come from the research. I looked at how teachers could use their experiences gained from the course in their classrooms. Regardless of whatever took place in the process of the study, I had to make sure that the research did not harm the participants and found a way to benefit them directly or indirectly. Teachers were supported in planning lesson plans and supported in subsequent lesson observations not only pertaining to formative assessment but also in moderating the internal formal assessment tasks.

The output of the study will be used not only in the development of a formative assessment course in the ACT programme. In addition, the study could contribute to the research community's understanding of formative assessment and be of benefit to professional developers including the Departments of Education.

3.12 Limitations of the study

Sarantakos (2013) identified some potential weaknesses with qualitative research:

- *Representativeness: It is based on small samples and hence does not produce representative results.*
- *Interpretations: There is no way of assuring that the researcher fully and correctly captures the true meanings and interpretations of the respondents.*
- *Quality of data: The nature of data collection leads to the production of large amounts of useless information.*
- *It generally takes more time to collect the data when compared to quantitative research.*
- *Data analysis is often time consuming.*
- *The results are more easily influenced by the researcher's personal biases*.

(2013, p. 46)

Some considerations for the qualitative researcher are discussed below in response to these concerns.

Regarding representativeness, in this study the process of research has been useful in understanding formative assessment even though it is based on small sample. It is hoped that these same tools could be used in different contexts and contribute to the general understandings of formative assessment in the field of education.

With respect to interpretations, it became clear to me that in order to do justice in qualitative research one must have a good command of language. I needed to be constantly vigilant in choice of words and descriptors in representing the perspectives of others.

With respect to quality of data, I carefully selected research methods in order to make sure that I collected the type of data that was required. Additionally, in reporting the research, I was careful to select only relevant data for the data presentation chapter.

Regarding the time involved in data generation and analysis, the focus of the study was limited to seven teachers, and two schools from the two metropolitan districts in the Western Cape as explained in section above. Time constraints did not allow for deeper conversations or reflections on the lessons observed during one of stimulated recall interviews. Regarding analysis, as a researcher, this simply required patience, but also, I am a teacher educator and although such careful analysis is an important process, it is not often something for which we have the luxury of time.

Finally, with respect to bias, the presence of the observer and use of capturing devices in classroom settings may have influenced the normal behaviour of learners as well as educators and thus posed a challenge on the true reflection of what happened. It was difficult to strike the balance between a measure of objectivity and trying to put the respondent at ease, due to the lecturer-student relationship between myself and the teachers. At the point of data generation, while recording observations I focused on suppressing my personal biases and prioritising what I observed in the field. Another data generation challenge was Creswell's (2012) concern that generation of data through interviews involves a complexity of social relationships that could affect the final product. Also, my role as lecturer meant that I needed to stay conscious at all times of my position of power and not impose my own opinions and expectations during our discussions.

3.13 Conclusion

The focus of this chapter was on the layout of the research and the research decisions that directed the research process. The data generation process, the tools employed and explanations of why I chose them, are presented. Each data generation tool assisted in

collecting useful specific data for this research. How the data was managed was also discussed. I described how data analysis was performed through all the four phases, using analysis tools. I also discussed how the research met ethical standards and how validity and trustworthiness were ensured.

In the following chapter, the findings of the study are presented. These findings portray the views, experiences and challenges regarding formative assessment practices of the teachers enrolled in the ACT: Natural Sciences Senior Phase at UCT.

CHAPTER 4: PRESENTATION AND ANALYSIS OF DATA

4.1 Introduction

In this chapter, the data is presented in four sections. The first section includes data which describes the seven teachers' views and experiences regarding formative assessment. This section presents the eight themes that emerged from data drawn from the seven teachers' semi-structured interviews responses and which were synthesised in Analytical Memo 1 (see Appendix 4). This data contributes to addressing Sub-question 1 of the study: *What are teachers' perspectives regarding formative assessment in their classrooms?*

The next section has two sub-sections which presents teacher classroom practices. The first sub-section is a description of lessons implemented by two of the teachers in the Western Cape Department of Education (see Section 3.6). For each of the two sets of lessons, the lessons are described drawing on: the pre-lesson discussion guided by the lesson plans that outlined the content to be taught; detailed descriptions of lesson observed including teaching and learning activities; and stimulated recall interviews. The second sub-section describes formative assessment strategies employed by the two teachers. This data contributes to addressing Sub-question 2: *What formative assessment strategies do teachers use in classroom situations?*

In the third section, data describing cognitive levels of the teaching and learning activities and assessments tasks are presented for each teacher. This data was generated from analysis of the teaching and learning activities and assessment tasks (informal and/or formal) and reported in Tables 4.2 and 4.4. This section was aimed at a deeper layer of analysis; that is, of the cognitive levels of the designed activities or tasks and how teachers and learners used these activities and assessment tasks to support conceptual understanding. This section addresses Sub-question 3: *How do teachers and learners use activities or tasks to support cognitive development to promote quality teaching and learning?*

The fourth and the last section in this chapter presents the challenges reported by teachers and those observed during lesson observations regarding effective implementation of formative assessment practices. This data was generated from the semi-structured interviews, lesson observations and stimulated recall interviews. This section was aimed at addressing Sub-

question 4: *What are the factors that hinder the effective implementation of formative assessment practices?*

4.2 Teacher perspectives regarding formative assessment

The data presented in this section comes from seven teachers' responses to the semi-structured interviews. Some quotations are provided to illustrate teachers' responses and/or aspects of their perspectives that fell within each of the eight themes that emerged from the data. The quotations were selected as being both representative and illustrative of the data gathered through the semi-structured interviews of this study. The data was indexed as T – teacher; n – number; IQ – interview question.

4.2.1 THEME I: Assessment as a way of fulfilling policy directives

The teachers were aware of different forms or types of assessments, especially those that are stated in the Natural Sciences CAPS document such as classwork, tests, research projects scientific investigations and more (see Table 2.1). They were also aware that various tasks help learners to develop their critical thinking skills as outlined in the CAPS document or according to the 'New Bloom's taxonomy framework of cognitive levels' (see Table 2.6). The knowledge of different types of assessments as per the CAPS requirements was evidenced by the following comments of the teachers:

> *Informal assessments are given orally as well as written tests. Formal assessments are only written tests and are used to test learners' level of understanding and how learners comprehend and interpret questions asked during the exams*. (T_2:IQ_1)
>
> *Learners will learn a selected amount of content and will receive a test based on the content as memory work. Set an amount of work and set the test and mark the test according to the memorandum … Examinations are required by the Education Department for comparing learners*. (T_2:IQ_1)
>
> *Informal assessments in the form of classwork, home works, and group work and also formal assessment tasks e.g. tests, examinations and assignments and projects are requirement of the WCED (CAPS) nationally*. (T_5:IQ_1)
>
> *Questioning should vary to cover all the learners in the class even those who are slow. There should be different types of questions, lower order, and the higher order depending on the level your learners are at.* (T_6:IQ_3)

4.2.2 THEME II: Formative assessment as means to improve planning

The focus of this section is on the teachers' conceptions of assessment as way of guiding their learning and teaching plans. Some of the interviewees recognised that lesson planning, including planning assessment tasks, is what guides teaching and learning. One teacher acknowledged the importance of planning, explaining that while one scopes the content to be taught, one should also think about and plan for assessment – "Assessment is one of the things that teachers don't take it serious and yet is very important in guiding one's planning." (T_1:IQ_1). This means that assessment, formative or summative should not be an after-thought, but should also be carefully planned. He sees planning for teaching and assessing as a cyclic process, when he says: "The teacher does planning and teaching-learning takes place then the teacher does assessment. This is a cyclic process" (T_1:IQ_1). From one teacher's (T_3:IQ_2) response, it was also clear that planning for teaching and assessing clarifies her thinking about what to teach and to assess thereof.

It was evident from three teachers that it is important to have flexible plans where one can relook at learner feedback and re-plan to address the aspects that learners are struggling with.

> *Formative assessment guides my teaching by directing me and telling me if learners are understanding the concepts at hand. Helps me to adjust the method, approach or even to* ***divert*** *the whole lesson to something of greater importance they should know before the concept at hand.* (T_5:IQ_5)
>
> *By evaluating their work, I also evaluate my approaches. If they get the concept right, it means the approach used is a good one and can be used again and the opposite is true*. (T_5:IQ_8)
>
> *Formative assessment is the type of assessment whereby the learners are assessed while the teacher is teaching, it is part of the lesson whereby a feedback is given to learners so that the teacher can be able to adjust his/her teaching practices based on feedback.* (T_4:IQ_4)

Teachers indicated how they adjust their plans as a way of responding to the information they have gathered and interpreted during their teaching process. This is key to formative assessment, to gather, interpret information and do something about your findings. The above quotes provide evidence of how these teachers look at formative assessment as a tool to improve their planning.

4.2.3 THEME III: Formative assessment as a way of informing teaching

This section presents teachers' views of formative assessment as a tool that informs their teaching. It was evident in teachers' responses that the intentions of formative assessment (as with summative) is to probe the extent of learners' grasp of content and concepts. Two teachers acknowledged an important aspect of feedback received from the evidence gathered from the learners. What the teacher does with the evidence of student learning is an important aspect of formative assessment. As noted in Section 2.4.3, assessment is only formative when teachers and learners do something about the feedback. Responses from teachers as sampled below, indicate that they use formative assessment in a reflective way, indicating when they need to re-teach, adapt teaching styles, adapt strategies, or divert a lesson in order to ensure conceptual development and to meet the needs of all learners.

> *Sometimes you might think your teaching is good, but when you assess you get the opposite of what you expected.* (T_4:IQ_2)
>
> *These practices help me to see if I am moving together with the learners. To check misconceptions, correct my methods or strategies, improve on my approaches, motivate learners identify individual learning problems, designing individual work to suit different learners, communicate with learners and parents*. (T_6:IQ_{10})

Teachers' responses also showed through the way in which feedback from their learners led to them changing direction to make sure that their learners understand and master the concepts taught. This is consistent with the understanding of Isaacson (1999; see Section 2.4.1) that assessments can be a means for teachers to appraise the effectiveness of the teaching strategies employed in their classrooms.

Wylie and Lyon (2013; see Section 2.4) viewed classroom discussions as one of the formative assessment strategies that can be used by teachers to extend learner thinking and understanding of the content/concepts taught. One teacher clearly used this strategy and the evidence he collected to inform his teaching. In response to semi-interview question 6 he said: *"It is important to give formative assessment during discussion to really know if learners are with you or understand. This helps me to re-teach it again"* (T_2:IQ_6).

The focus here is on the teacher's concept of formative assessment as a tool to assess how effectiveness of his/her teaching.

> *These practices affect learning by challenging both the teachers and learners to focus on learning and teaching process. Enabling learners to see where they are weak or strong.* (T_5:IQ_{1a})

> *They help me to come up with activities so that I can help them to close the gap my learners have.* (T_7:IQ_5)

4.2.4 THEME IV: Formative assessment as means for scaffolding individual learning

In Section 2.2.2, scaffolding in education is addressed and some examples are given. In this section, teachers' expressed the view that formative assessment can be used as way of developing individual learners' skills for independent learning. Their responses indicated how formative assessment strategies they employ in their classrooms support student learning. Looking through three teachers' responses where they described some activities they employ in their classrooms, it can be noted that various tasks that are given to learners serve as 'scaffolding tools' (see Tharp & Gallimore, 1988; Shepard, 2005; see Section 2.5.1). These teachers stated that they engage their learners in questioning, classroom discussion, peer assessment, classwork, homework and group work.

Questioning, whether to elicit learner prior knowledge or probe learner understanding, is one of the five 'key' strategies of formative assessment. In the case of T_2, questioning is used to elicit understanding of the concept – *"Questioning to see if they understood the lesson"* (T_2:IQ_{1a}). If teachers plan and orchestrate questions carefully, they can be a tool to create effective classroom discussion.

Allowing learners to interact with one another helps them to develop their interpersonal intelligence and companionship amongst themselves which also has an enormous impact on learners' learning (see Shepard, 2000 in Section 2.2). This is in accordance with Vygotsky's view, that mental development and functions are facilitated through social interactions and that competence is the result of several performances by learners with the help of others (1978). This interaction could be facilitated by the teacher through classroom discussions and engaging learners in peer assessment. T_3, in response to interview question 1a, described the nature of assessment as follows:

> *Peer assessment, learners work in pairs and use rubric provided and provide feedback (positive only) to the concerned peer. Learners prepare a*

> *speech and are given a rubric or checklist beforehand... and class discussion is provided.* (T_3:IQ_{1a})
>
> *Informal assessment in the form of classwork, homework and group work.* (T_4:IQ_{1a})
>
> *By using the Bloom's taxonomy order of questioning and assessment. To oversee all learners' abilities and also to know where to assist or give support.* (T_7: IQ_3)

For example, one teacher (T_2) highlighted important aspects of formative assessment that guide his learner-support process. Using classwork "*after every lesson or topic to know if the learners really understood the lesson, so that I can also see if I have to re-teach the lesson or not"*. Classwork is a useful tool to support learners and give them the criteria for success or modelling the way to approach the work at hand. He also acknowledged that formative assessment can be used to support student learning: *"Formal assessment with the guidance of the teacher, it is better when the learner explores and learns by himself."*

4.2.5 THEME V: Formative assessment as preparation for summative assessments

One of the purposes of formative assessment, as stated in the CAPS document, is to give learners regular feedback to enhance the learning experience and build towards formal assessment (see Section 2.3.4). This section presents teachers' views of what formative assessment strategies teachers use to prepare their learners for summative assessment (tests and examinations). Two teachers responded as follows in this regard:

> *Formative assessments are yardsticks to assess where learners are in their ability to understand test questions asked and their ability to answer them. Learners can be asked to mark their work and identify their mistakes and this can help them when writing the test.* (T_2:IQ_4)
>
> *Informal assessment is the day to day assessment preparing learners for the formal assessment practising activities or short tasks that could be used for formal assessment which will help in the first term reports*. (T_5:IQ_1)

Examinations and/or tests can be intimidating for some learners. One teacher (T_3), in response to semi-structured interview question 1, explained that she gives her learners tests frequently so that they can be familiar with written examinations processes and environment. For one teacher (T_7), getting learners to reflect or present their work could boost their confidence when taking a test or examinations. She said:

You give them group investigations, but to make sure they participate, all must reflect individually. It may be verbally or in writing. It also affects the individual learning which build the confidence when give a test. (T_7:IQ_1)

4.2.6 THEME VI: Formative assessment as a tool for reporting and learner promotion

Some scholars in the field of formative assessment agree that there is a thin line between formative assessment and summative assessment (see Section 2.4). One definitive feature of formative assessment though is that it is not an occasional event (term test or exam), but is part of effective daily teaching and learning practice. Formative assessment is any teaching practice that collects, interprets and uses evidence of learner performance to improve teaching and learning.

Three of the seven teachers in this study stated summative assessments, such as tests and examinations (mid- and or end-year), were examples of formative assessment. They viewed formative assessment as a yardstick of learners' level of understanding and academic performance (achievement). However, it was not evident from their responses how they use feedback to promote student learning. They rather used it to inform their decisions on whether the learner should progress to the next class or not. The following responses suggest that various forms of assessments were employed to develop a sound report of learner progress:

Formative assessment is assessment that is recorded – for report usually at the end of the year. (T_1:IQ_4)

To see how many 1 – 7 scale learners, verification of results, improvement, motivation.(T_1:IQ_5)

Formative assessment is the one that leads learners to be promoted to the next grade, or it shows the parents the progress of the learner during each term during the year. It gives full report of the learner's progress in school. (T_6:IQ_4)

These assessments help the progression of learning, so that the child can progress to the next grade… (T_7:IQ_1)

Those are the forms of assessment that are used to measure an individual learner performance and to attach the status of progression e.g. not ready to progress or progress with support etc. (T_7:IQ_4)

4.2.7 THEME VII: Formative assessment as a tool to promote learner-learner collaboration

This section presents data that illustrates the view of teachers that they implement group work to create a learner-centred environment where learner-teacher and learner-learner relationships are encouraged. The four quotes below indicate how teachers use learner groups to scaffold learning (see Section 2.2.2) and how they involve learners in assessment and involve them in classroom discussions not only for conceptual development but also for developing certain dispositions:

> *Group assessment – the class is grouped heterogeneously and given a section of work to share with the class. This encourages them to help one another.* (T_3:IQ_1)
>
> *Peers appreciate being evaluated by peers especially when it is positive.* (T_3:IQ_1)
>
> *Informal and formal assessments is done so that peer and group can be involved in the assessment.* (T_6:IQ_1)
>
> *… be able to work with other learners in group discussion to stimulate their self-esteem and leadership skills in learning. It also affects the individual learning which build the confidence when given assessment. Because you promote learners to assist each other.* (T_7:IQ_1)

4.2.8 THEME VIII: Formative assessment as a way of promoting quality learning

Quality learning, as defined in Section 1.6, is learning that fosters an individual learner's ability to acquire knowledge and understanding which is utilised within real situations to make valid, informed decisions, and enhances the individual's ability to be positively involved in the sharing of ideas, understanding and opinions. In response to semi-structured interview question 3, three teachers responded as follows:

> *Quality learning is when learners are interacting. They are responding to the subject matter in a meaningful way, they ask questions. They are not afraid to give their opinions. They are learners that are not only recipients, they are participants. This indicates to me whether I achieved sufficient depth and scope.* (T_2:IQ_3)
>
> *Quality learning is when all learners engage and feel a sense of achievement" "I mean when learners understand and pass well a piece of work they were doing." "Critical thinking is essential and this is assessed via questioning techniques and worksheets and giving them many opportunities.* (T_3:IQ_3)

> *Quality learning is when learners are motivated to get new knowledge using hand-on or practical work activities, interacting with the environment and the ability of learners to see their strength and weaknesses. Even teachers to critique themselves as to improve their approaches.* (T_5:IQ_3)

Two teachers' responses suggested that they implemented formative assessment strategies not only to ascertain the quality of their learners' learning but also their understanding of their responsibility as teachers to teach for quality (see quality teaching in Section 1.6) in supporting learner's learning of broader range of cognitive, social and specific academic skills. This was evident in their following responses:

> *I engaged in these practices because I want to know the progress of my learners not just in the cognitive level but also in skills and values.* (T_7:IQ_4)
>
> *Questioning should vary to cover all the learners in the class even those who are slow. There should be different types of questions, lower order, and the higher order depending on the level your learners are at.* (T_6:IQ_3)
>
> *I use these tasks to clearly see the extent of the learning gained by the learners beside the oral questions or classwork given to them. It was used to assess the deep understanding of the learners regarding the concepts taught.* (T_4:IQ_4)
>
> *Quality learning is when learners are able to understand the content and are able to display their understanding on the different assessment strategies you engage them in. You engage them because you want to assess if the set of objectives of the lesson have been reached or if the skills have been acquired.* (T_4:IQ_3)

4.3 Teacher classroom practices regarding formative assessment

The data presented in this section was generated during the lesson observations of two teachers (see Section 3.7.2). The section has three sub-sections which presents teachers' classroom practices regarding formative assessment. The first sub-section is the description of the lessons taught by the two teachers. The description draws on the Phase II analysis (see Section 3.9) of the pre-lesson discussion, observations and stimulated recall interviews. The second sub-section presents teachers' classroom practices regarding formative assessment and addressing Sub-question 2: *What formative assessment strategies do teachers use in classroom situations?* The third sub-section presents an analysis of the learning and teaching activities including the assessment tasks using data from the Phase III analysis (Tables 4.2 and 4.3). This section addresses Sub-question 3: *How do teachers and learners use teaching*

and learning activities and assessment tasks to support learner cognitive development and promote quality learning and teaching?

4.3.1 Lesson descriptions

This section is a description of the implementation of two lessons. Data is reported in three parts each drawing on a different data source. Data from the pre-lesson discussion presented a brief background of where the lessons observed fit in within the broader topic (first part). The second part presents a description of what was observed during lesson presentations to give a sense of how teachers implemented formative assessment strategies. Stimulated recall interviews focused on how the teachers felt about their lessons, if they had achieved what they set out to achieve and where to improve.

4.3.1.1 Mr Tall lesson descriptions

a. Pre-lesson discussion

Mr Tall (pseudonym), a fifth-grade teacher, was finishing off a three-week long lesson on 'energy and electricity' which covers three concepts in the Grade 5 Natural Sciences and Technology curriculum – cell and batteries, mains electricity and safety with electricity (CAPS, p. 40). At the time of observation, he was teaching the concept 'Safety in using electricity' (see Appendix 7a). The lesson intention was to make learners aware of the dangers of electricity and the importance of using electricity safely and with care. At the end of the lesson, the learners were expected to display their understanding of the topic by creating an awareness poster.

b. During the lesson

Mr Tall started off the lesson by reviewing the previous lesson to elicit learners' responses relating to what they had learned. After a dialogue between him and the three learners who shared their learnings, he moved on to the next part of the lesson. In the next activity, he showed learners a video from his mobile phone, of a person being shocked by a badly insulated train wire track. He moved from group to group showing the video. Once all groups had viewed the video he asked them to reflect on what they saw. After a few learners' responses, he closed off this section by saying: *"That is why girls and boys I want to emphasise why it is important to take certain safety precautions when you are using electricity"* (TRT1:L97-98).

Next, Mr Tall involved the class in a chalkboard activity, where learners had to fill-in the missing words (see Figure 4.1 below). The same three learners who participated in the previous activity completed this exercise too.

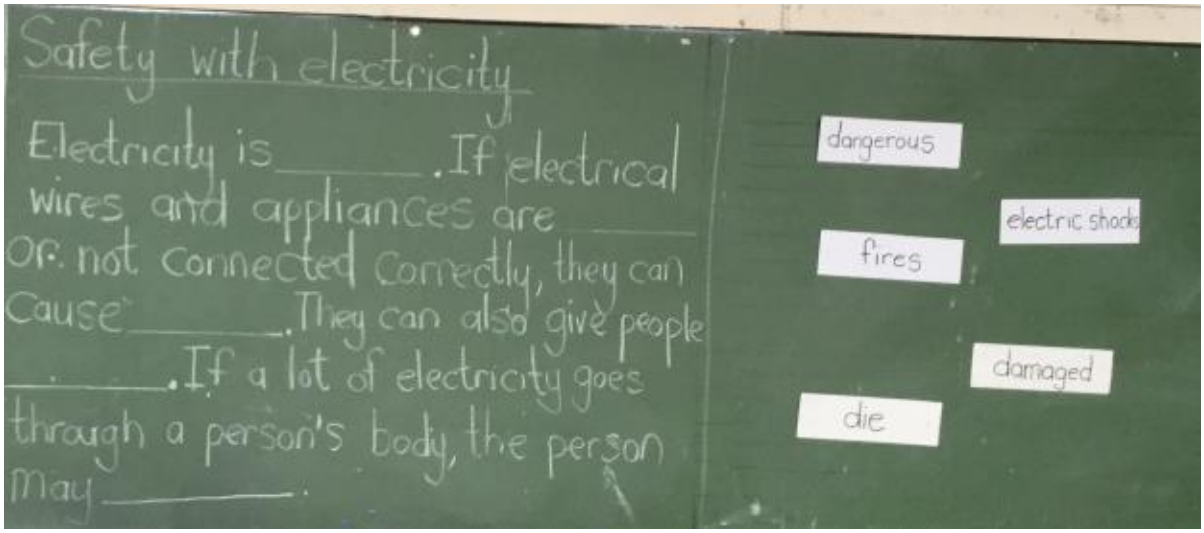

Figure 4.1: Classwork on safety with electricity

In the next activity on 'Warning signs', Mr Tall distributed an A4 size photocopied page (see Appendix 7b) and then asked one learner to read the information. As the learner was reading, he stopped her at intervals, asking the class questions pertaining to the signs and relating them to the video clip shown earlier and to real world situations. He said:

> *These signs indicate high voltage. Can you see them? Have you ever seen this sign before? In your area, maybe? "There's a picture of an electric box there (pointing to the picture on the page) that supplies electricity to your community. Do you see it? That main switch there.* (TRT1: L134-144)

The teacher wrapped up this activity by asking learners to take note of anything with the danger sign written on it: He said: *"Take the sign serious, if you ignore it you might find yourself being electrocuted. Keep away from anything with this sign written (pointing to the picture on the 'warning signs' information sheet) somewhere on it"* (TRT1: L165-167).

The last activity for the first day's lesson involved an authentic case study on 'Illegal connections' (see Appendix 7c). Learners were asked to read the case study individually and as a group, answer the last question – why do you think there is load shedding in South Africa? He gave the learners five minutes. While the learners were discussing their answers, Mr Tall went to each group listening to their discussion, but there was no clear evidence of

how he interacted with the groups. After five minutes, he asked the groups to share their answers with the whole class. All groups presented their group answers except one that wrote individual learner responses. When the teacher asked them why they had done this, they said they could not agree on one answer that would capture their views on why there is load shedding in South Africa. Here are some answers from the groups:

> *Because people steal electricity and they do not pay for it.*
>
> *People leave geysers and pools on and that's why we have load shedding. It cannot hold everyone's plugs.*
>
> *We as a group say many people in South Africa use too much electricity and that's why South Africa has load shedding.*
>
> *She said people waste electricity and don't want to pay by leaving plugs and lights on. He thinks people steal electricity and can't afford it.* (TRT1:L183-270)

The next day, Mr Tall started the lesson by distributing 'Mrs Kokoropo's family use of electricity' (see Appendix 7d). This activity required learners to carefully look at the pictures presented on the worksheet and identify pictures that indicated either responsible or irresponsible ways of handling electrical appliances. Learners were asked to do the activity as groups and present their findings and suggestions to the whole class. The same learners who presented in the previous activity presented their group answers.

The next activity was poster design; Mr Tall distributed the information strips with instructions and an A3 poster board sheet to each group. For the poster, learners had to design an awareness poster about safe use of electricity. The groups had to decide about their target audience, and identify a place to display their poster. Some groups re-wrote what was on the script, some drew and others cut and pasted pictures.

On day three, the groups presented their posters one after another. In all the groups, each learner presented sections of the poster. The presentations were characterised by each presenter reading what was written or displayed on the poster.

c. Stimulated recall interview

The stimulated recall interview session started by viewing some parts of the video recording (see Section 3.7.2). The discussion began with my asking Mr Tall to reflect on the three-day lesson and restating what he was hoping the learners to learn at the end of these lessons. He

said: *"I just wanted them to be aware of what are some of the dangers that involve electricity, that it should not be taken lightly and there are certain safety measures that you need to take when you work with electricity"* (SR:T_1).

Overall, he thought the lessons went well and the learners were engaging even though not in the way he had expected.

> *I think they understood that, because they could engage and answer questions during the presentations and explain to me what will happen if they must put, for example, a metal spoon in the wall socket …what are the dangers when they do that. (SR:T_1)*

When he was asked to reflect on the final task, that is, poster development and presentation, he laughed and voiced his frustration on the way the learners presented the posters. He acknowledged that most, if not all the groups, read what they wrote on the posters.

> *Not really because I wanted them to speak more and to express themselves more and I did not get that. I'm not too sure whether they were shy or they were excited to be on camera but that's not what happened.* (SRI: T_1)

His assumption was that the learners would use the presentation skills that he taught them in the English class. *"… I did tell them they should make eye contact and don't read from the poster they should know what they are talking about, research a topic thorough before you come and present it"* (SRI: T_1).

His other frustration, as an Afrikaans speaker, was that he could not understand what the learners were saying during discussion sessions because they were speaking in isiXhosa. He said: *"I can't help the learners when they speak their language (Xhosa)"* (SRI: T_1).
On the issue of timing, in terms of the poster development and the quality of the work presented by learners, he also voiced his disappointment. Mr. Tall acknowledged that time was not enough and there were no available resources for the learners to develop high quality work.

> *I think the time was probably too short. Normally I give them something like this for a week to go and do the research about the topic and make a poster and to elaborate on the content.*
>
> *I gave them the information, yes most of them did use the information effectively and some just wrote it down. I don't think they comprehended what it means. That's why I asked them what does that mean.* (SRI: T_1).

4.3.1.2 Mrs Nyoka lesson descriptions

a. Pre-lesson discussion

Mrs Nyoka (pseudonym), a Grade 7 teacher at Thembalethu (pseudonym) Primary School, was observed for two consecutive 55 minutes and later a 10-minute follow-up session for a stimulated recall interview. Mrs. Nyoka was finishing off a three and a half-week Natural Sciences topic that would include the development of the Grade 7 learners' understanding of the concept of biodiversity. The focus of the two lessons observed was on human impact on biodiversity. Her main concern was to fulfil the curriculum assessment requirement (the research project). One of the four formal tasks (summative assessment) requirements is the research project worth 50 marks (CAPS, p. 92) and she chose that they do this project on human impacts on biodiversity.

The pre-lesson discussion with Mrs Nyoka took place just before the lesson to be observed. She presented a two-day lesson plan which outlined what the teacher and learners were going to do during the lesson and stated the final assessment research project. She also presented the materials she would use for the lesson, that is, a two-page copy from a textbook; vocabulary and reading notes; the research task instructions and the marking rubric (see Appendix 8a for lesson plan and 8b copy of textbook section). Mrs Nyoka verbally stated the lesson intentions during this session, saying,

> *I am hoping that the learners, through what we are going to do in class regarding biodiversity and their own research will know and understand the human impact on biodiversity. I also want them to come up with ways to prevent or protect our biodiversity.* (PrLD: T2)

In the lesson plan Mrs Nyoka indicated that the topic biodiversity is introduced in Grade 6 and she explained during the pre-lesson discussion where the topic fits in within the broader Grade 7 Natural Sciences curriculum specifically in the 'Life and Living' strand: *"In Grade 6 these learners did ecosystems and food webs. Biodiversity is addressed in Grade 7 just after the concept on 'requirements for sustaining life'."* (PrLD: T2). This gave an indication of what prior knowledge learners should bring from the previous grade. This also shows Mrs Nyoka's consciousness of progression in her subject.

It was clear to Mrs Nyoka that learners would not be able to master the learning objectives in the two period lessons. She selected activities that the learners would do in class and one

major research task that they would do outside classroom periods. The materials prepared for these activities were, twelve A5 hand-written cards with the word 'biodiversity' with 18 information cards of animals and plants; a short video clip from YouTube on biodiversity; a textbook and additional notes; and a project instruction sheet with its marking rubric. All these materials were organised before the lesson and she had prepared a copy of handouts for each learner. The activities were planned for learners to explore and examine the science content on biodiversity.

b. During the lesson

In this class, the learners were arranged in rows facing the board with one learner per table. The seating was according to cognitive abilities and those that were of higher cognitive development were at the back rows and the first rows were those that were experiencing various challenges. Mrs Nyoka presented a series of activities. She started by engaging learners through playing an ice-breaker in which they identified the word biodiversity in a game called "Hang-man". The game was over in about four minutes. One learner challenged Mrs Nyoka for not writing enough dashes and thus he could not guess what the word was. In her response, she said, *"Well I've tricked you there, Themba (pseudonym)"* (TRT2: L33).

For the first activity Mrs Nyoka gave the first two rows of learners the 'biodiversity' cards to paste onto the board. The rest of the class was given information cards of animals and plants – one or two cards each. On one side of the card there was a picture of either an animal or a plant and on the back, there was the name and some information. The learners were asked to look at the picture and guess what it was before they looked at the information on the other side of the card. This took them five minutes and Mrs Nyoka asked those who could identify their animals/plants to raise their hands. Most of the learners with cards raised their hands except one. This learner felt he was the only one who got it wrong, and he commented: *"Ma'am, I think I'm the only who did not get it right"* (TRT2: L53).

Mrs Nyoka tried to put the learner at ease by pointing out that his was not easy and she could have not been able to identify it either. *"Yours was harder one. It was jolly hard, I wouldn't have recognized that one, believe me"* (TRT2: L54). She also the others: "*So well done to those that got it right the first time"* (TRT2: L55).

She continued with this activity and asked the learners to paste their cards below the corresponding letters of 'biodiversity'. She started by calling out the learner with the

animal/plant starting with ‘B’ and ending with the letter ‘Y’. This created a picture of biodiversity in animals/plants. As the learners came up, pasting their animals/plants they announced the name to the class. If it was not a common one, the teacher would ask some questions and in most cases, she answered her own questions. She also engaged learners with everyday life concepts, like asking about the South African national bird. Mrs Nyoka shared what she had heard on the radio about Botswana, about wanting to change their national bird and flower. In some instances, misconceptions were observed

T: What is an orca? (TRT2: L76)

L: A whale. (TRT2: L77)

The teacher continued with the lesson without correcting the misconception. A common name for an orca is a ‘killer whale’. This can create confusion as the orca is actually a type of dolphin.

After pasting up the first three letters, Mrs. Nyoka, checked their prior understanding of the concept ‘BIO’.

T: What is this word? what am I seeing?

L: Bio.

T: Yes, Zodwa (pseudonym).

Ls: Biotic (mumbling)

T: Bio, what does the word bio mean?

L: Biosphere (whispering).

T: Saying it louder. … What does bio mean?

L: Blood (TRT2: L75 -91)

T: Bio is to do with living things.

For this activity, most of the learners were involved and showed great interest and a few seemed skilled in general knowledge. However, there were a few that were not active at all even though the activity was of a lower order level. The teacher was happy seeing the majority participating. She came to me at the back of the class, excitedly saying, *“You know, I thought they were going to be bored with this activity. Can you see how they are engaging? I don't believe this!”* (TRT2: L) Then, she went back to the front and continued with her lesson.

The next activity was the YouTube video clip on biodiversity. With this activity, Mrs Nyoka wanted to give her learners more information about biodiversity and reminded them about related concepts that were covered in Grade 6 – concepts like ecosystems and food webs. She asked the learners to take notes of important things while listening. Here she used the teaching strategy of listening with intent, helping them to focus while watching the video. From time to time she interrupted the video and asked them questions (TRT2: L257 -270; L: 274-278). Mentioning the project for the first time, she said:

> *Now just bear in mind, how does this apply to your project? That is what you should think about all the time. Yes, it's nice, but how does it apply to your project that we've got to do? That's what I want you to keep on thinking about. …I want you just to pick up few points about our topic biodiversity. I want you to be able to use these notes in your project.* (TRT2: L229–232)

Next Mrs Nyoka asked learners to write down the three aspects of biodiversity she had wanted them to capture from the video:

> *There they are ecosystems, species and genetic diversity. Genetic diversity means variations that we have. Write ecosystems, species and genetic variations. Have you got that down? Because those are your three main focus in terms of biodiversity.* (TRT2: L274-277)
>
> She closed off by saying, *"Alright we've just seen ocean ecosystems, we've seen jungle ecosystems."* (TRT2: L277-278)

The next activity involved looking at additional notes on South African Biodiversity. Mrs Nyoka distributed notes to each learner. She spent about 25 minutes on this part of the lesson. She started off by relating her experience visiting the Kirstenbosch National Botanic Gardens a few days ago, telling them that she learnt about different animals and plants and that South Africa is the third most biodiverse country in the world. She also shared the sad news that there several animals and plants that were extinct. These were recorded at Kirstenbosch in an area called the 'graveyard'. There were also some that were endangered and at risk. She mentioned that these animals/plants were vulnerable, in danger and extinct through the doings of human beings. She continued this session by reading through the notes, giving explanations of terms, and giving the learners the chance to ask questions (see notes in Appendix 8c). However not enough time was provided for them to engage with the text or information.

On the second day of the lesson, Mrs Nyoka began by recapping terms from the previous lesson. These were endangered, extinct, vulnerable, rare, threatened and endemic. Once more, she encouraged the learners to take note of terms/vocabulary on the handout. She asked one of her learners if she understood those terms, but the response was negative. At this point she decided to allow the learners to read through the terms and their explanations. She called out different learners to read and asked the class to underline the parts on the sentences that gave a definition or description or meaning of the term. At the end of this session she again directed the learners to the project, and she said: *"Grade 7s are we getting the idea of these terms? I need to see them in your project, right. They are so important. That's why I've spent so much time talking about them yesterday"* (TRT2: L579).

In this session, she also asked learners questions checking their understanding of the terms, but giving little time for learners to think about the questions raised. She got them to think about the human impact on biodiversity, asking them application questions. Learners came up with different negative ways human beings impact on biodiversity, such as deforestation, pollution and overfishing (TRT2: L581-633).

The next activity provided more opportunity to get information on biodiversity and the humans impact on it. The teacher distributed a textbook (*Step Ahead Series: Natural Sciences, Grade 7*) which is different to the prescribed one. She used this textbook as an additional resource. She asked the learners to read three pages. Again, she gave them time to read as individuals and after they finished reading she asked them questions based on what they had read. Eight learners gave their reflections on what they had read in the passage. One of them gave an account of a 'big thing' close to where she lives that records rhinoceros (rhinos) killings.

> *There is a big thing there close to my house whenever we run on Saturday we run past, and there's like a sign. And they have … how many rhinos have been killed. So, every time it's killed they just lower the number.* (TRT2:L679*)*

Mrs Nyoka moved on with the lesson, but there was at least one learner who had not finished reading the section. After he exclaimed, *"… I'm not finished reading"*, she said: "*That's fine, we are going to read together"* (TRT2: L702 – 703). However, there was no time in the lesson to come back to this.

She moved forward, reminding the learners what activities they had done and reassuring them that they have had enough information for doing the research project. Pointing to the handout ,she said: "Alright, you've got that information on both sides *of the hand-out* (the italics = the teacher pointing to the hand-out). You have now a textbook. That's loads of information that you are able to use for this project" (TRT2: L709 – 710).

The teacher took most of the remaining thirty-five minutes taking learners through the research project instructions. She read all eight questions first and then read and explained the scoring rubric, looking at each criterion and using examples and giving learners a chance to answer some of the questions as follows:

> *Look at the rubric now, keep that next to you, but cast your eye on the rubric please so you can see how the questions match the rubric … Number one, what is biodiversity?... so, in the first criteria it says 'Knowledge of biodiversity, definition … do you see that? Question one is asking what is diversity? Is that not a definition?* (TRT2: L728 – 735)

In the remaining five minutes, Mrs Nyoka gave learners a chance to start their research by writing a structure of the report and answering questions in their planning books. The final project was due in two weeks-time. She encouraged learners to submit a draft before the final submission.

c. Stimulated recall interview

The stimulated recall interview session took place the following week. This was a short discussion since the teacher did not have much time. Mrs Nyoka's lessons were audio recorded and the interview started by listening to some parts of the audio recording and looking at the lesson plan. The discussion started by asking Mrs Nyoka to reflect on the two-day lesson and restating what she was hoping the learners would learn at the end of these lessons: She said:

> *I think the lesson went well, I managed to cover all the issues that would help my learners when doing this long overdue project. They have everything they need and I took time (as you might have noticed) to even accommodate my front row friends and explain the rubric. I think all know what to do.* (SRI: T2)
>
> *My intentions for this lesson was to give learners much information on biodiversity and through their own research to make them aware and understand the human impact on biodiversity. I wanted them to come up with ways to prevent or protect our biodiversity.* (SRI: T2)

She was pleased by the way the learners were engaging during the lesson, especially at the beginning of the lesson. She said: *"I'm still surprised by the way these learners participated on the diversity cards. It was my first time doing that activity when we were at Kirstenbosch and I said let me try it with them, I think they loved it*" (SRI: T2).

When she was asked to reflect on the final task, that is, the research project, on how she was going to monitor the progress of the project. She said: *"A plan is for them to bring their work, whether as a draft on their draft books or typed task so that I can give them feedback. The big challenge, as you know is time. I'm not sure if this will be possible to fit in, but it's a plan"* (SRI: T2).

4.3.2 Quality of formative assessment in practice

This section discusses the data drawn from the observations of the two teachers as described in Section 4.3.1 above. The data presented in this section highlights the strength of formative assessment practices based on: lesson plans, which includes, teaching and learning activities and assessment tasks; pre-lesson discussions; classroom observations; stimulated recall interviews. The analysis is organised according to the 'Ten Dimensions of Formative Assessment' (Section 2.4.3) to understand the extent to which teachers and learners engaged in quality formative assessment and altered teaching and learning based on formative data. Structuring the analysis this way is not intended to compare the teachers per se, but rather as an examination of common patterns, strengths and challenges regarding formative practices. Dimensions 7 – self assessment and dimension 8 – peer assessment are not addressed, simply because they were not observed during lesson observations.

The grading tool (see Appendix 9) for the dimensions of formative assessment made the characteristics of stronger and weaker implementation of formative assessment strategies explicit. It is important to remember that the rating or grading describes the level of implementation of an aspect of practice, for an example, lesson goals/objectives, not the level of expertise of a teacher (Wylie & Lyon, 2013). Analysis using level descriptors can be challenging as sometimes the evidence did not exactly match the description of one level but rather cuts across two or more levels. In such a case, professional judgment was used to select the level that was most representative of the observed practice.

The data further revealed strengths and weaknesses regarding formative assessment practices observed in the two teachers' lessons. Some examples of effective formative assessment practice drawn from the observations are also presented where applicable.

4.3.2.1 Dimension 1: Clarifying goals

Both, Mr Tall and Mrs Nyoka were clear (in the pre-lesson discussion) about their lesson goals. What was also clear in their lesson plans was where the topics fit within the Natural Sciences curriculum. In Mrs Nyoka's case, she indicated how her lesson had progressed from the previous grade. However, both teachers did not make connections from the current lessons to previous and future learning, nor shared the learning goals at the beginning and right through the lesson. At the beginning and during the lesson, the lesson goals were not clearly and/or explicitly stated or communicated to the learners. Mr. Tall began the first lesson with revision There was no observed evidence of linking each electricity lesson with each previous lesson. Even though Mr Tall checked learners' understanding of the previous lesson. This exercise was rushed and there was no clear explanation of how the previous day's knowledge was linked to the current lesson or topic. There was no evidence that the learners had strong hooks to link what they had learned to the new knowledge.

4.3.2.2 Dimension 2: Clarifying criteria for success

For the electricity lesson, there was no evidence of the teacher sharing the criteria for success with the learners. In the biodiversity lesson, the criteria for success were shared with the learners through continuous reference to what was needed for the research project on 'human impact on biodiversity'. At the end of the lesson, Mrs Nyoka introduced the research project and gave the learners a marking rubric she planned to use to evaluate their research project. She explained the rubric and discussed with learners how they should go about answering the guiding questions using the rubric. She gave them the rubric to use as the reference of the quality she expected them to produce.

4.3.2.3 Dimension 3: Tasks and activities that elicit evidence of student learning

In this dimension both lessons had activities that could drive learning. Teachers showed evidence of clarifying the activities for learners. Both teachers planned activities that were appropriate for the learning objectives. However, there was not enough time for most learners

to engage with the information presented to them and there was little evidence of engaging **most** learners in class.

In Mr Tall's case, all activities had a series of planned questions related to safety of using electricity. The learners were to read the information and discuss the questions posed, as groups. Each group was to reach consensus on a single answer, write on a piece of paper and that group answer was then shared with the rest of the class. All the activities learners did in Mr Tall's class were appropriate for the learning objectives and learners were given opportunities to discuss and present their understanding in their own ways. Allowing learners to work in groups is an attribute of effective formative assessment. Learners presented their groups' responses to the whole class, sharing their groups' understanding. Mr Tall, though, did not have a mechanism for synthesising evidence from learners, even through an informal review process. He also missed an opportunity for allowing the learners to discuss their responses as the whole class. Discussion, in which learners are led not just to present but also to talk about their understanding. This provide the opportunity for the teacher to respond to and re-orientate the learners' thinking. Additionally there was little evidence of collecting evidence of student learning for formative feedback.

In Mrs Nyoka's case, she also provided her learners with carefully crafted activities that could elicit student learning. As an attribute of effective formative assessment, Mrs Nyoka allowed opportunity for the learners to ask questions, even though time did not allow her entertain most learners to raise questions that would lead them to the understanding human impact on biodiversity. Another attribute of effective formative assessment was when she asked to watch the video clip on biodiversity and to take notes. This could have been an opportunity to discuss biodiversity and elicit learner understanding of the concepts related to biodiversity. However, there was no evidence of Mrs Nyoka following up what the learners captured from the video clip.

4.3.2.4 Dimension 4: Questioning strategies that elicit evidence of student learning

Both teachers raised questions as a direct way of checking student learning. What was evident in both classrooms, was that few learners were answering questions and presenting the group responses. Even though thought-provoking questions were asked, the waiting-time

for learners to engage and respond to questions was not provided. There was not much emphasis on eliciting evidence of student learning at the time of observation.

4.3.2.5 Dimension 5: Feedback loops during questioning

In both lessons, learners were given little time to engage with texts and few responded to the teachers' questions. This meant that learners were not engaged in fruitful discussion and allowed time to explore ideas in a meaningful way. In Mrs Nyoka's lesson, when she realised that one learner did not understand the meaning of the terms, she asked the learner to re-read the definitions and she explained them. This was an attribute of effective formative assessment, where Mrs Nyoka used the feedback from the learner to make adjustments to her teaching.

4.3.2.1 ***Dimension 6: Individualised descriptive feedback (written or oral)***

During lesson observations for both teachers there was no evidence of learners receiving oral feedback either in groups or as individuals. Mr Tall moved from group to group while learners were busy with the activities; however, there was no evidence observed of him giving individual nor the group feedback regarding the task at hand. This was also true in Mrs Nyoka's class. There was no oral feedback regarding the concepts addressed, however, she did engage with questions regarding the structure and the format of project report. It can be assumed that learners would have been given written feedback on their projects, but this was outside the scope of this research.

4.3.2.7 Dimension 9: Collaboration

In both classrooms observed, it seemed that the relationship between teacher-learner and learner-learner interactions were healthy. In both classes an open teaching and learning environment was observed. However, how the teachers and learners work together toward a common goal was not evident. As mentioned in the first dimension above, there was no evidence of clarifying the goals. The focus was not on learning but on teaching and assessment of learning. The classroom culture, as proposed by Shepard (2000) (see Section 2.4.3.9) requires a learning environment where learners and teachers would have a shared expectation that finding out what makes sense and what does not is a joint worthwhile exercise, essential toward taking the next step in learning.

In Mr Tall's class learners work in groups was evidence of a learning environment that promoted collaboration. It seems that learners were used to working in groups and sharing their group work with the whole class. What was also evident, though, was that it was the same individual learners presenting their group work (see Section 4.2). In Mrs Nyoka's class teacher-learner interactions were limited to one or two learners that asked and answered questions. Learner-learner interaction was not evident since the lesson was dominated by teacher-teaching. There was no collaboration nor an opportunity for learners to engage one another's viewpoints.

4.3.2.8 Dimension 10: Use of evidence to inform learning and teaching

In this section, the focus is on how teachers used the evidence collected. In Mr Tall's lesson even though he saw that learners were not complaining about the way he taught them in the English class he never took the opportunity to use that evidence and adjust his teaching –*"I did tell them they should make eye contact and don't read from the poster they should know what they are talking about, research a topic thorough before you come and present it."* (SRI: T_1). Assessment becomes formative once the teacher and learners use the evidence gathered or feedback to adjust teaching and learning (see Section 2.4.3.10).

In Mrs Nyoka's class, as described in Section 4.3.1.2, there was no evidence of learner understanding or misunderstanding the concept of biodiversity except one learner who could not identify his assigned animal card. Mrs Nyoka did not respond in a way that helped this learner understand the description of the animal and how it fits in, in the activity they were engaging in.

4.3.3 Teaching and learning activities and tasks that elicit student learning

This section of the study, presents a further analysis of the classroom observations. It analysed teaching and learning activities and final assessment tasks that the two teachers observed used at the time of lesson observations. The data presented in this sub-section is drawn from Phase III analysis. The activities and tasks for both teachers are presented in Table 4.1 below and are analysed using the CAPS cognitive levels for assessment (see Table 2.2) and the 'New Bloom's' Taxonomy (see Table 2.6) of cognitive development.

Table 4.1: Teachers' teaching and learning activities and assessment tasks

	Teaching and learning activities and assessment tasks	
#	**Mr Tall**	**Mrs Nyoka**
1	**Class work** – fill in missing words	**Biodiversity cards** – arranging cards to spell out BIODIVERSITY
2.	**Warning signs** – reading information and looking at pictures	**Video clip on biodiversity** – watching with intent (teacher asked questions after watching video)
3.	**Case study** – comprehension	**Reading notes on biodiversity** – read notes
4.	Mrs Kokoropo's family use of electricity	**Reading textbooks** – learners read passages from textbook and teacher asked questions after reading the passages
5	**Assessment task** – Design and present a poster on safe use of electricity	**Assessment task –** Research project guided by eight questions with marking rubric

The analysis of the teaching and learning activities and assessment tasks for both teachers are done in two ways. By first analysing the activities and assessment task as they are recorded as part of the lesson plan using Dalton's 'New Bloom's' taxonomy of cognitive development and CAPS cognitive levels. In Tables 4.2 and 4.4 are activities and tasks the teachers prepared for their lessons are recorded and levels of cognitive development are also indicated. The first column outlines the nature of activities and assessment tasks the teachers planned for learning experiences in class and outside the classroom (research for Mrs Nyoka's learners). The second column shows the cognitive process domain by looking at the instructions or description of the activities or tasks. The questions asked to elicit student learning were used as a guide for assigning the knowledge domain presented in the third column. In the fourth column the cognitive level at which the learners would be operating when engaging with the materials provided to explore science ideas are assigned against each activity.

The second layer of analysis of teaching and learning activities and assessment tasks is presented in Tables 4.5 and 4.6 for Mr Tall and Mrs Nyoka respectively. The framework proposed by Dalton (2003) was used to define how the various activities or tasks are aligned to the learning objectives stated by the teachers. By using the taxonomy table, an analysis of the objectives of a unit or topic, among other things, is an indication of the extent to which more complex kinds of knowledge and cognitive processes are involved. Since objectives from 'Understand' through 'Create' are usually considered the most important outcomes that

denote higher order critical thinking, their inclusion, or exclusion, will be apparent from the 'New Bloom's' Taxonomy (Dalton, 2003).

In the context of the taxonomy of cognitive development and looking at the complexity of educational and teaching objectives, the clues from the nouns and verbs in the teachers' verbal statements were used to align the activities/tasks (see Tables 4.3 and Table 4.5). Elements that were looked at to provide these clues were: (i) objectives – general purpose/aims or/and topic objectives; (ii) teaching and learning activities – particularly teachers' language when activities were introduced to learners; (iii) also considered were the questions teachers asked the learners and the learners asked the teachers and the assignments or homework the learners were given as part of or as a follow-up to the activity; (iv) the final assessment task. In these cases, the indicators of the cognitive dimensions came from the assessment instructions or descriptions as well from the evaluation marking scheme or rubric criteria used to judge the adequacy of learners' performances on the task.

4.3.3.1 Mr Tall's teaching and learning activities and the assessment task

In the table below, Mr Tall's activities are presented and analysed using Dalton's 'New Bloom's' taxonomy of cognitive development (with its cognitive process and knowledge dimensions) and the CAPS cognitive levels for assessment.

Table 4.2: Mr Tall's teaching and learning activities and final task cognitive levels

Activity	**Cognitive processes dimension**	**Knowledge dimension**	**Cognitive levels**
Class work – fill in missing words	Remember	Facts	Low
Warning signs – reading information and looking at pictures	Remember	Facts	Low
Case study – comprehension	Understand	Facts	Middle
Mrs Kokoropo's family use of electricity	Understanding	Facts & concepts	Middle
Final task - Poster on safe use of electricity	Create (using facts)	Facts	Higher
Poster presentation	Remember	Procedure	Low

Looking at Table 4.2, Mr Tall prepared activities that could develop learners' understanding of the precautions that should be considered when using electricity. The activities ranged from simple to complex and were designed to develop learner's critical thinking. In the final

task, he used a task that called for learners to use higher order levels of cognitive development, to create and present an information poster.

Table 4.3 presents the classification of Mr Tall's lesson objectives and activities that were used to facilitate the achievement of the set objectives. This table shows the alignment of activities with the set objectives. Mr Tall stated that he wanted to make learners (a) aware of the dangers of electricity and (b) aware of the importance of safety when using electricity and using it with care (see Section 4.3.1.1). Framing this objective, the way theory suggests (see Section 2.5) could be written as follows: By the end of the lesson learners should be:

- aware of the dangers of electricity; and
- aware of the importance of using electricity safely and with care

Placement of objectives along the knowledge dimension requires a consideration of the noun "dangers of electricity". Dangers of electricity would be associated with factual knowledge. So, it would be classified as an example of A: Factual knowledge.

Table 4.3: The placement of Mr Tall's lesson objectives, teaching and learning activities and assessment in the Taxonomy Table

Educational objective: The learners will be aware of the dangers of electricity and the importance of using electricity safely and with care.						
Noun: • the dangers of electricity • importance of safe use electricity				**Verb:** • making them aware • using		
	The cognitive process dimension					
The knowledge dimension	1. Remember	2. Understand	3. Apply	4. Analyse	5. Evaluate	6. Create
A. Factual	Objective 1 Remember facts Activity 1 Activity 2 Activity 4		Objective 2 Apply facts Activity 3			Objective 3 Creating poster using facts Activity 5 [assessment final]
B. Conceptual/Principle						
C. Procedure						
D. Meta-cognitive						
	Knowledge		Skill	Capability		

Concerning the placement of the objective along the Cognitive process dimension, it was noted that there are two **verbs**: **making aware** (teaching/telling) and **using**. 'Making them aware': 'aware' implies knowledge gained through one's own perceptions or by means of

receiving outside information, in this case, the teacher giving them information. Awareness implies once they are aware of something (dangers of electricity and importance of using it safely and with care), they will have gained knowledge by means of the information they will have been given by the teacher. Therefore, this would be classified as 'Remembering'.

Using or implementing, would be 'Applying'. Since both categories of cognitive processes are likely to be involved (with learners expected to remember facts before they can apply), this objective would be placed in two cells of the Taxonomy Table 4.2: A1, remember factual knowledge, and A3, applying factual knowledge (see Table 4.2). To check evidence of learning, the teacher asked learners to create an awareness poster. Even though this was not part of the stated objective, it implies that creating a poster would be one of the outcomes of the lesson and thus putting this objective also in A6: Creating a poster using facts.

4.3.3.2 Mrs Nyoka's teaching and learning activities and the assessment task

In Table 4.4 below Mrs Nyoka's teaching and learning activities and the final task are presented and analysed using Dalton's 'New Bloom's taxonomy' of cognitive development and the CAPS cognitive levels for assessment. As shown in this table, Mrs Nyoka prepared activities to develop learner's critical thinking. The final assessment task was highly scaffolded.

Table 4.4: Cognitive levels of Mrs Nyoka's teaching and learning activities and final task

#	Activity	Cognitive processes dimension	Knowledge dimension	Cognitive level
1	Biodiversity cards	Remember	Factual	Low
2	Video clip on biodiversity – watching with intent	Remember	Conceptual	Middle
3	Reading notes on biodiversity– reading with intent	Understand	Conceptual	Middle
4	Reading textbooks – biodiversity	Understand	Conceptual	Middle
5	**Assessment task –** Research project guided by eight questions:	Create (using concepts/principles)	Conceptual	Higher

Table 4.5 presents the classification of Mrs Nyoka's lesson objectives and activities that were used to facilitate the achievement of the set objectives. The table shows the alignment of activities with the set objectives. Mrs Nyoka stated the lesson intentions and said:

“I am hoping that the learners, through what we are going to do in class regarding biodiversity and their own research will **know** and **understand** the human impact on biodiversity. I also want them to **come up** with ways **to prevent or protect** our biodiversity.” (see Section 4.3.2). The final task (research on human impact on biodiversity) called for the learners to use what they learned in class and to take it further and look for more information on this topic and then to show by listing or stating, ways in which they can prevent/protect biodiversity.

Framing Mrs Nyoka’s stated lesson objective and looking at the final task’s expectations, the way theory suggests (see Section 2.5), this could be written as follows:
By the end of the lesson learners should:

- know and understand the human impact on biodiversity;
- write a report on human impact on biodiversity and come up (list/state) ways to prevent or protect our biodiversity.

Placement of the objectives along the knowledge dimension requires a consideration of the noun “human impact on biodiversity”. Human impact on biodiversity would be associated with conceptual knowledge. So, it would be classified as an example of B: Conceptual knowledge. The activities that supported the achievement of this objective were activities 1-4 (see Table 4.4) .

Table 4.5 The placement of Mrs Nyoka's lesson objectives, teaching and learning activities and assessment in the Taxonomy Table

Educational objective: By the end of the lesson learners should know and understand the human impact on biodiversity, write a report on human impact on biodiversity and come up (list/state) with ways to prevent or protect our biodiversity.						
Noun: • human impact on biodiversity • report	Verb: • know and understand • write and list/state					
The knowledge dimension	The cognitive process dimension					
	1. Remember	2. Understand	3. Apply	4. Analyse	5. Evaluate	6. Create
A. Fact						
B. Concept/Principle		Objective 1 Understand concepts Activities 1 - 4				Objective 2 Create using concepts Activity 5
C. Procedures						
D. Meta-cognitive						
	Knowledge		**Skill**	**Capability**		

Concerning the placement of the objective along the Cognitive process dimension, it was noted that there are three verbs: (i) know and understand: this implies that through the information gained in class and from the research the learners will gain knowledge and understanding of biodiversity concepts; (ii) write a report: this implies once they have acquired the conceptual knowledge, they will be able to produce a report including (iii) ways in which they can prevent or protect biodiversity. Writing a report, therefore, would include creating a list of ways of protecting or preventing biodiversity loss. This was placed in 6 'create' in the cognitive process dimension.

4.4 Barriers to implementation of effective formative assessment practice

In this section factors that hinder effective formative assessment practice across data sources, that is, semi-structured interviews of seven teachers, as well as lesson observation and stimulated recall interviews with two teachers, are presented. Three questions on the semi-structured interviews protocol addressed factors that inhibit the implementation of formative assessment strategies. The responses of the teachers to this question highlighted several challenges they are experiencing and they suggested some ways in which these challenges could be addressed. Some of these challenges were evident in the two classrooms observed and the two teachers confirmed certain challenges during the stimulated recall interviews.

The data revealed that teachers also experience challenges in terms of implementing effective formative assessment strategies, including structural, technical, language of teaching and learning, and attitudinal challenges that accompany fundamental changes to educational systems and teaching and learning practice.

Classroom size and the number of the learners thereof pose a challenge for the two teachers as revealed in their comments below:

> *How am I going to do it when I have more than 50 learners in my class?* (T_4:IQ_5)
> *Large number of learners in a small classroom makes it difficult to teach and assess learners.* (T_6:IQ_{11})

Additional contributing factors raised by two teachers is poor infrastructure and not enough resources. Even though there is a classroom allocated for a science laboratory, the size and its condition hinder effective learning.

> *The classroom that is dedicated for science experiments is small and the floors have holes. This makes it impossible to check if all learners are working.* (T4:IQ11)
>
> *There is a need of properly maintained science labs, science kits and classroom enrichment and excursions*. (T_3:IQ_{11})

Despite the teacher acknowledgment of the importance of formative assessment, they reported limited time to plan to assess learner understanding and to adjust their teaching accordingly. It was evident, during the lesson observations, that time is a problem not only for teachers but also for learners. Teachers need more time to implement all the activities effectively. Despite their good intentions, teachers simply had insufficient time with learners.

For Mr Tall, learners were to design, develop and present the poster on 'Safety in using electricity' – due to time constraints, learners did not produce posters of quality.

> *I think the time was probably too short. Normally I give them something like this for a week to go and do the research about the topic and make a poster and to elaborate on the content.*

Mrs Nyoka, also shared a clear message pertaining to time limitation – she did not have time to mark the project or give learners feedback.

> *A plan is for them to bring their work, whether as a draft on their draft books or typed task so that I can give them feedback. The big challenge, as you know is time. I'm not sure if this will be possible to fit in, but it's a plan.* (SRI: T_2)

In part, the teachers' sense of limited time emanates from the rigid curriculum pacing guide that creates pressure to cover the content rather than slowing down and re-teaching as needed. The curriculum pacing is aligned with summative or formal assessment (see Section 1.1 and Section 2.2). This is evident in the following responses to the challenges experienced when using formative assessment:

> *In my school timetable changes a lot during the term and every week there are tuition disruptions which disorganise the whole teaching plan.* (T_1:IQ_{11})

> *Time consuming, there is limited time to assess learners and give feedback. The CAPS pacing does not allow time for even get deeper to content. It does not give time to look back and re-teach concepts that learners don't understand.* (T_4: IQ_{11})

Even though teachers are expected to use informal assessment (see Section 2.2) to drive teaching and learning, teachers struggle to find the right balance between formative assessment and summative assessment practices with the current curriculum and formal assessment demands. One teacher commented:

> *The pressure of content coverage so that by the end of term you are ready to test the learners as per CAPS requirement makes it difficult to strike the balance between informal and formal assessment. We must make sure learners are ready for the tests.* (T_3:IQ_{11})

Mrs Nyoka at the time of observation was faced with this challenge of fulfilling CAPS formal assessment plan and said: "*I think the lesson went well, I managed to cover all the issues that would help my learners when doing this long overdue project. I managed to cover all the issues that would help my learners when doing this long overdue project"* (SRI: T_2).

Three teachers raised the challenge of the language of teaching and learning. Learners who are not English language speakers are not able to either read or write in English and this also appears to inhibit classroom discussions. This issue was reiterated by Mr Tall during the stimulated recall interviews (see Section 4.3.1): *"I can't help the learners when they speak their language (Xhosa)"* (SRI: T_1).

Below are extracts from three of the teachers' semi-structured interviews:

> *The biggest challenge is to get students to understand the questions asked, which mainly the lack of reading ability. Reading to understand which different from just reading.* (T_2)
>
> *Learner not understanding the concepts due to lack of core knowledge that should be applied and language to access the assumed knowledge.* (T_5)
>
> *Learners suffer language barriers more especially in Grade 4 and Grade 5.* (T_6: IQ)

In some cases, a negative perception of formative assessment was evident. One teacher commented *"It is a waste of time"* (T_4:IQ_5). Another teacher commented that the negative attitude of learners towards attending school and doing their work makes it difficult for him to implement formative assessment practices: *"Learners absent themselves, not submitting tasks this is a problem to give them feedback"* (T_2:IQ_{11}).

In responding to what could be done to address these challenges, teachers came up with some suggestions on how curriculum could be managed by reducing the activities that lead to teaching and learning disruptions – *There should be consistency and no school disruptions (T_1)*. Two teachers acknowledged the impact of teaching and learning time management, in the sense that for teachers to be able to give or receive feedback, the curriculum should be managed properly so that teachers and learners can have time for effective implementation of formative assessment – *Making time to use the information or feedback during school time. This should be included in the school timetable* (T_5). *If more time was permitted to cover work, the depth and more skills would have been covered. Meeting more of the learners' needs and interests (hopefully)* (T_3).

Two teachers suggested that for teaching and learning to be effective, the teaching and learning environment should be conducive and teachers need to be monitored and be

accountable regarding assessment – *Conducive learning environment, regular tests on concepts taught, adequate apparatus. Accountability, teachers need to be monitored so that they don't just give the learners one end-term test (T_1).*

One teacher suggested that both learners and teachers need to be motivated and that there needs to be a reasonable teacher:learner ratio for effective implementation of formative assessment – *Average number of motivated learners … and informed highly motivated educators, so that learning can be effective* (T_4). T_6 shared the same sentiment as T_4 in terms of the number of learners in the classroom. This is evident from her response – *Number of learners in class is so big that makes me as if I cannot manage my class. We need to reduce the number of learners per class or reduce learner intake* (T_6). T_6 also suggested subject allocation should be according to teacher expertise and Continuing Teacher Professional Development as she responded in the quote below:

> *Teacher development, allocation according to teacher's specialization (subject), closes monitoring and staff development sessions because the teacher is the major resource in teaching and learning. A better equipped educator can produce best results, of course 'good plants growth'.* (T_6)

4.5 Conclusion

In this chapter, data was presented from three different sources, semi-structured interviews, classroom observations (that included pre-lesson discussions and stimulated recall interviews), and document reviews as described in Chapter 3. My research journey and what transpired during the data analysis was presented for the readers. South African education policy guided the study into what is expected from the teachers regarding assessment in general and formative assessment in particular. CAPS as a guiding policy should have an influence on not only what to teach but also what to assess and when to assess and which assessment strategies should be employed. This partly enabled me to answer Sub-question 1 *"What are teachers' perspectives regarding formative assessment in their classrooms?"*. Teachers' responses in semi-structured interviews generated eight themes that gave me insight into how participating teachers in this study understood and perceived policy directives, and the rationale behind formative assessment strategies and techniques. Data indicated that all teachers understood the value of formative assessment in learner cognitive development. The data also revealed that teachers are experiencing certain challenges regarding formative assessment implementation. What was encouraging from the data was

that teachers proposed a range of solutions that could correct the schools' status quo regarding implementation of effective formative assessment.

From the two teachers' lessons observed, both teachers prepared teaching and learning activities and assessment tasks that could develop their learners' conceptual understanding of the topics taught. However, the data revealed teachers used some form of formative strategies but not many opportunities for the learners to engage in a more productive way. Quality scaffolding fell short due to chasing curriculum coverage and fulfilling assessment policy directives.

Lastly, the data also revealed challenges that teachers have regarding implementation of quality formative assessment and some of these challenges were observed during the lesson observation of the two teachers. Chapter 5 presents further interpretation and discussion on what transpired from the data.

CHAPTER 5: INTERPRETATION AND DISCUSSION OF FINDINGS

5.1 Introduction

In Chapter 4 data generated in this study was presented and analysed. Teachers' perspectives, experience and classroom practices regarding implementation of formative assessment were reported. In Chapter 4, findings on constraints reported by teachers and those observed during lesson observations were also presented.

In this chapter, the implementation of formative assessment strategies by primary school Natural Sciences teachers are discussed. Discussions are drawn from the data presented in Chapter 4 and guided by the theory presented in Chapter 2. These discussions are aimed at answering the research question and sub-questions asked in this study (see Section 1.5).

5.2 Discussion of findings

5.2.1 Teachers' perspectives on formative assessment

Formative assessment is important in all subjects and is part of teaching and learning in the schooling system. The data presented in Section 4.2 suggested that the teachers understand and acknowledge the value of assessment in general and of formative assessment (informal) in particular. All teachers in this study described how they use various forms of assessments and some explicitly mentioned formative assessment strategies they use and why they use them.

Section 4.2 presented data from teachers' views regarding formative assessment practices, responding to Sub-question 1 – *What are teachers' perspectives regarding formative assessment practices?* The data revealed diverse lines of thinking on how teachers in this study implement formative assessment. This is evidenced by the eight themes that emerged from the analysis of the data. The eight themes suggest that teachers are quite clear regarding policy directives and purpose of formative assessment; this was evident in their semi-structured interview responses. The eight themes revealed that teachers understand the need to have flexible plans if one plans to implement formative assessment effectively. Some mentioned their teaching is informed by the evidence they gather regarding student learning and adjust their teaching accordingly (Section 4.2). The data revealed that teachers use formative assessment as a way of scaffolding learning (Section 2.5.1) by using different

activities that allow their learners to be active during teaching (Section 4.2). In this way they claimed they can make a judgement also on quality learning by looking at how learners respond to subject matter.

The data revealed that traditional forms of assessments, like pen-and-paper written work, are still a dominant and a widespread practice of the teachers involved in the study. This was evidenced by the examples of activities and/or tasks given by the teachers as formal or informal assessments used in their classrooms (see Section 4.2.1). These pen-and-paper (written tests, examinations) assessments have been a centre of criticism in the South African curriculum reforms in which tests and examinations are still dominating as ways of assessment (see Section 2.3.2). Hence, the changes or inclusion of other forms of assessment, for example, projects and research based tasks, in the CAPS. Realising the need for these kinds of assessments, some researchers (Black & Wiliam, 1998b; Wiggins, 1998; Koch, 2005; Dada et al.(2009); Wiliam, 2014) suggest that traditional assessments, such as tests should be positioned in a way that will strongly support and prepare learners to complete more complex tasks.

The teachers' realisation (Section 4.2.8) that assessment should not be designed solely to measure learners' progress but also to advance their teaching (Miller & Seraphine, 1993) is an indicator that they understand the importance of assessment (formal or informal) in teaching and learning. Teachers have long been encouraged to be more reflective of their classroom practices and use their assessments as a tool to diagnose possible teaching and learning needs (Wylie & Lyon, 2013; South Africa. DOE, 2011d; Koch, 2005; Black & Wiliam, 1996). In this way, a more meaningful teaching and learning experience can be developed by utilising assessment results to develop pedagogies more effective in helping learners to learn (Harris et al., 2009; Martone & Sireci, 2009).

5.2.2 Teacher classroom practices regarding formative assessment

The data (see Section 4.3.2) also revealed that several attributes of effective formative assessment (learning progression; learning goals and criteria for success; feedback; collaboration) were used by the two teachers observed. Having identified these attributes of effective formative assessment, the data revealed, though, that teachers had no planned system of collecting learner evidence of learning, that is, use of formative techniques to drive

the formative assessment strategies (see Table 2.4 for formative assessment techniques). This could be the result of the lack of emphasis on or drive of formative assessment in the South African education departments and hence lack of depth and quality of formative assessment practices.

Both teachers presented lessons that provided some examples of strategies of effective formative assessment. Overall their lessons could have been strengthened through sharing of learning goals and through inviting more learner-participation and allowing learners to take ownership of their learning. These dimensions in the Wylie and Lyon (2013) 'Ten dimensions of formative assessment' emphasise the importance of learner understanding of the intended learning of a lesson and criteria for success because they better prepare learners to engage with the content at hand and impact on positive learning. When learning goals are integrated into the lesson, they support student learning. Regarding the criteria of success, research suggests that, when learners understand what quality work actually looks like they are more able to demonstrate their own learning. Mrs Nyoka provided her learners with the rubric and she explained it, making sure that learners understood what they were expected to do for their research report. In Mr Tall's case, expectations were not shared explicitly and thus no criteria of success were used.

Areas such as raising questions that stimulate classroom discussion, classroom collaboration amongst learners and learner-teacher collaborations would be effective strategies for encouraging learner participation (Section 2.4.3). In both classrooms, few learners engaged with the teacher (see Section 4.3). In the electricity lesson, learners were given opportunities to engage in discussion, but the recording tools used were unable to capture their dialogue. It was encouraging though to see that the classroom environment of both teachers was conducive for learning. A classroom culture in which both teachers and learners seemed to be partners in learning was observed. Both classrooms were orderly, clean and the environment felt managed and in control.

Teachers used activities and tasks that could elicit student learning and which were pitched at suitable levels or complexities of cognitive development (see Table 4.1). However, implementation in practice did not seem to elicit the expected student learning. Although teachers used a variety of activities, there was no smooth transition between these activities and there appeared to be little opportunity provided for more learners to engage with the

materials. It seemed that both teachers had in mind ideas about what learning their learners could develop and thus they had prepared this variety of activities. What was evident during the lesson observations was the limited time for facilitation of the learners' thought processes (see Section 4.3.1). The process of performing the activity and reflecting on it is one of the important aspects in learning. The time for the learners to reflect on the activities planned was limited and there was no evidence observed of the learners' reflection processes that could lead to the construction of new ideas.

In Mr Tall's class, learners engaged in a range of activities as groups (see Section 4.3.3.1). However, learners were merely asked to work in groups but the purpose and the benefits of group work were not explained and thus there was no evidence of learners' understanding of the value of the type of learning when working with their group members. As described in Section 4.3.3, the same individual learners repeatedly represented the group outputs. Mr Tall missed opportunities to provide clear instructions when facilitating in-class group work to help the learners understand what good group work looks like and what they were expected to accomplish, through the group work activities. Clear instructions for the learners would have provided better understanding of expectations.

Bringing the groups back together as a whole class to share their responses is an important component of group work (see Section 4.3.1). What was missing though was the whole class discussion, where learners discuss their ideas and end with a teacher-led summary to consolidate the lesson. Another possibility for improving group work is to incorporate roles for specific group members which is an important aspect of effective group facilitation to encourage learner participation and develop learners' skills in efficient group functioning.

The case study of illegal connections and Mrs Kokoropo's family's use of electricity (Section 4.3.1.1) was a good example of how the classroom lesson can be linked to a 'real life' situation. The guiding questions that lead the learners through the activities were of higher order level. But Mr Tall missed the opportunity to engage learners in a meaningful group and classroom discussion. As these learners were working in groups there was no observed evidence of learning as individuals.

In the lesson presented by Mrs Nyoka, learners were confronted with many terms to grasp and understand within a very short period of time (see Section 4.3.3.2). Mrs Nyoka wanted to

create an awareness of human impact on biodiversity. In order for people to make an informed decision they need information about the state of an environment. In Mrs Nyoka's lesson, it seemed that the focus was on providing the information with the assumption that, through research, the learners would be able to apply their knowledge to develop a greater awareness of human impact and change their behaviour (Dreyfus et al., 1999).

> *I am hoping that the learners, through what we are going to do in class regarding biodiversity and their own research will know and understand the human impact on biodiversity. I also want them to come up with ways to prevent or protect our biodiversity.* (PrLD: T2)

Mrs Nyoka's class was expected to do further research on the human impact. The lesson might have been strengthened by assisting learners with strategies for conducting the research. Both teacher's lessons had potential for allowing learners to explore real world situations. For example, Mr Tall's lesson dealt with safety in using electricity, which is an issue that was relevant for the learners in his class. In both teachers' classrooms, thinking time was limited due to rushing to complete the sessions within allocated time (as per CAPS). Evident in both lessons, was that teachers did not have time also to ascertain learners' thinking. A teacher's role is to assist in the development of conceptual thinking, and they can only do that when they understand what their learners present in relation to the concepts being taught. As Vygotsky wrote, for teaching to be effective a "child's thought must be known and understood" (1962, p. 85) so that teachers can work effectively within the child's zone of proximal development to maximise the effectiveness of learning.

It seemed that both teachers needed more practice and support to improve implementation of formative assessment strategies, particularly in areas of clarifying learning goals and areas that invite more learner participation and taking ownership of their learning. Overall, both teachers seemed to be strong in preparing teaching and learning activities that could elicit student learning. The sequencing of the activities was carefully orchestrated, but not enough time was allowed for more learners to engage with the materials and this affected opportunities for quality formative assessment and feedback. Tasks and activities that elicit student learning focuses on the things with which learners engage that potentially produce evidence of student learning. Therefore, when learners are engaged in tasks and activities on their own and with others, the work products should provide evidence of learner understanding. These should also indicate the extent to which learners engage in higher order thinking activities and their capability to convey their learning with clarity (Wylie & Lyon, 2013).

Both teachers' intentions of facilitating thinking experience as well as active experiences through the teaching activities (Table 4.1) appeared to be undermined by the pressure of delivering. Thus there was little time for engaging learners in meaningful ways to discuss the concepts.

5.2.3 Factors that inhibit implementation of effective formative assessment practices

Section 4.4 presented data from the teachers' views and challenges regarding formative assessment practices, responding to Sub-question 4 – *What are the factors that hinder the effective implementation of formative assessment practices?* The barriers that inhibit the implementation of effective formative assessment practices (see Section 4.4) that were cited by the teachers and observed during lesson observations are discussed below.

5.2.3.1 Pacing and Time

Despite teachers' acknowledging the importance of formative assessment, they reported limited time (Section 4.4) to plan to assess learner understanding and the need to adjust their teaching accordingly. In part, the teachers' sense of limited time emanates from the rigid curriculum pacing guide (Section 4.4) that creates pressure to cover the content rather than slowing down and re-teaching as needed. The curriculum pacing is aligned to summative or formal assessment (see Section 2.3.4). Falling behind the curriculum pacing guide poses difficulties for both teachers and learners since these formal assessment tasks come with high-stakes accountability measures that have an impact on teacher evaluation and school performance ratings.

Teachers feel pressure to ensure that their learners' are ready for the formal assessment tasks. The pacing challenge or limited time to cover prescribed content and preparing learners for the formal assessment tasks was evident in Mrs Nyoka's class (Section 4.4). Mrs Nyoka had to rushed through the activities she prepared for her learners making sure they had all the information so that they could do their research project (Section 4.31.2): *"Now Grade 7s you have enough information to do your project …"* During semi-structured interviews, teachers also cited lack of time to solicit learner understanding because of frequent interruptions of the school programme and constantly changing school timetable or class schedule (see Section 4.4).

5.2.3.2 Large class sizes impact the effectiveness of formative assessment implementation

Classroom size and the large number of learners in the classroom were also cited as a challenge by the teachers in terms of implementing formative assessment effectively. Infrastructure, not having a big enough classroom to accommodate large number of learners and enough resources were also cited as contributing factors (see Section 4.4). Because formative assessment strategies are mainly classroom-based and require teachers to change their practice, teachers find it difficult to manage their classrooms. This obviously would pose barriers to formative assessment practices.

5.2.3.3 English as a language of teaching and learning has an impact on effective formative practices

In Section 1.1, English as the language of teaching and learning was posed as a challenge for non-English speakers. The semi-structured interview data revealed that three student-teachers raised the language of teaching and learning as a challenge. Learners who are not English language speakers struggle to read and write in English and this also appears to inhibit their participation in classroom discussions (see Section 4.4). This challenge is thus one of the potential hindrances to classroom collaboration and discussions.

5.2.3.4 Addressing the challenges

Teachers seemed to see some of these above-mentioned circumstances as beyond their control and felt that there was nothing they could do about them. However, some of them could see possibilities for change. Some suggestions to address these challenges, as noted in Section 4.4, seem to indicate that teachers are aware of the challenges as hindrances to quality teaching and learning. Their aspiration of providing their learners with the best teaching and assessments possible is hindered by these issues addressed above. Their proposals or suggestions on how to change the situation confirms with their understanding that teaching and learning are both important aspects of the schooling system. Their suggestions can be summarised as follows: protection of teaching and learning days by reducing activities that disrupt teaching and learning; timetabling should also include time for formative assessment so that learners can get feedback; conducive learning environment and maintain teacher:learner ratio; teacher expertise should be considered when doing subject allocation and support Teacher Professional Development. A clear message was conveyed in

the statements or responses presented in Section 4.4, that if some of these challenges could be addressed, effective formative assessments practices would be possible.

5.3 Summary and recommendation

This section presents a summary of the research findings in relation to the research question and sub-questions. I then present the concluding remarks, limitations and provide insights into possibilities and opportunities for further research.

5.3.1 Summary

The study sought to explore teachers' use of formative assessment strategies as a means to raise classroom standards and to foster higher order cognitive development of learners. The investigation employed an interpretive case study approach where data were collected using semi-structured interviews, lesson observations and stimulated recall interviews and document analysis.

The semi-structured interview was used to ascertain teachers' views regarding implementation of formative assessment in their teaching and learning processes. The eight themes that emerged from the data answered Sub-Question 1 of this study as they provided insight into how teachers understood and perceived policy directives, rationale and techniques for formative assessment and their experiences of putting these ideas into practice. The data revealed that teachers were using formative assessments for varied reasons or purposes and eight themes emerged from the data.

Despite the fact that teachers acknowledge the importance of formative assessment and what is required of them in terms of practice, it is worth noting that tests and examinations are still dominant practices in their schools. This was evident in the examples given of forms of assessments they employ in their classrooms. The data also revealed that teachers were not only aware of how best to utilise learner evidence of learning but they were also conscious of their weaknesses in this area. This suggested that teachers are open to further training and supports the hope that effective implementation of formative assessment will eventually be part of their teaching.

This study supported the idea that well-structured and designed formative assessments perform a significant role in students' learning as well as the professional development of teachers. Formative assessment strategies used effectively can provide a rich data source for teachers and educational administrators including school management that goes beyond appraisal of learners' levels of academic performance where their strengths or weaknesses are revealed. Teachers suggested that pedagogical enhancement regarding formative assessment practices and scaffolding learning all aimed to serve both learners' needs and teachers' interests. Teachers are committed to developing and growing to become better teachers that can deliver quality education for their learners. Their contribution to such outcomes of quality education was one of the reasons why formative assessment practices should be given much attention in the educational system.

The data generated from lesson observations answered the research's Sub-Question 2. This question required a description of how teachers implemented formative assessment. The analysis for this question made use of the 'Ten dimensions' of formative assessment (Wylie & Lyon, 2013) for evaluating the quality of strategies employed by the teachers. A closer link between classroom teaching and formative assessment is not an obstacle-free process, and it does not simply happen by chance. The relationship between teaching and formative assessment is an endeavour that is ever challenged by various factors such as teachers' subject knowledge, teachers' pedagogical content knowledge, and their attitudes.

The data revealed that both teachers had good intentions to support learning and some several attributes of effective formative assessment were observed, such as, providing learners with learning progression criteria for success and an environment that focused on learner collaboration. The results from this study indicated aspects of formative assessment strategies which could be strengthened in the two observed classrooms at the time of the investigation. The results showed that clarifying goals, feedback and classroom collaborations could benefit from more attention in the classroom. These seem to be the strategic entry point to begin strengthening the effective implementation of these formative assessment dimensions. Implementation of effective formative assessment of course is not free from obstacles and will not simply happen by engaging teachers in the theory.

Data generated to answer Sub-question 3 provided insight into teachers' formative assessment practices with emphasis on lesson planning that included lesson objectives or

goals, teaching and learning activities, and assessments, and how these three aspects were aligned to promote quality teaching and learning. CAPS cognitive levels and Dalton's 'New Bloom's taxonomy' (2003) were used as a lens to look at cognitive levels of the activities and assessment tasks as well as alignment between learning objectives, teaching and learning activities, and assessment components and thus inform the quality of implementation.
For both teachers who were observed teaching, the teaching and learning activities were mainly guided by learners answering closed-ended questions. For example, the research project conducted by Mrs Nyoka's class was structured in a similar way to the usual tests which are characterised by a set of closed-ended type of questions. There were, however, some questions that clearly provided opportunity for learners to elaborate their answers, relate what they know from other subjects and apply their school knowledge to the real-life contexts.

Data generated to answer Sub-question 4 provided insight into structural, material, learner participation and language challenges regarding formative assessment implementation. Semi-structured interviews were used to ascertain teachers' views regarding factors that hinder implementation of effective formative assessment. The semi-structured interviews provided an opportunity for teachers to share some of the challenges experienced regarding formative assessment implementation while trying to bring about quality education for their learners. Teachers also shared some ways of dealing with these challenges.

5.3.2 Recommendations

Since formative assessment is a fundamental part of teaching and learning, teachers need more support and time for reflection to improve their implementation of effective formative assessment. Teaching and assessment (formal and informal) both take place in actual classroom context and involve real people, that is, teachers and learners. One of the key concepts of formative assessment is feedback which works in two ways, to help learners improve learning and enable teachers to make adjustments to their teaching. Feedback is designed to close the gap between learners' current and desired level of learning and performance. The study reveals that teachers need enough time to be able to implement effective formative assessment practices. This needs curriculum developers and administrators to revisit curriculum coverage in terms of breadth and depth and to give more time for the implementation of effective formative assessment practices.

The five ‘key’ strategies of formative assessment proposed in this study (Section 2.4.2) clarify what effective formative assessment is, but they provide little guidance for teachers about how to apply these strategies in the classroom. For that reason, formative assessment techniques (Table 2.4) are used to implement these strategies. Therefore, teachers need to be engaged in a pedagogical developmental processes that will support them in using these techniques. Over and above, teachers would need adequate support from the school administrators. Keeping the balance between teaching and assessment, both formal and informal assessments is an endeavour which is continuously challenged by various factors such as content knowledge, pedagogical content knowledge, classroom contexts, and teacher attitudes, to mention a few. It is for these reasons that schools need to be sensitive of these factors since they might impede effective implementation of formative assessment practices.

5.3.3 Reflection on the study

It is important to remember that this study was exploratory and merely laid the groundwork for deeper and broader future investigations. It was conducted with seven teachers of which two were closely observed in classroom situations. The findings are suggestive rather than conclusive. The areas identified for extending and strengthening formative assessment practices in the two classrooms may not be generalised across the teachers’ classrooms or for their everyday teaching for the entire year. To validly assess the implementation of effective formative assessment strategies, a similar study could be conducted involving longer engagement with teachers and learners.

5.4 Concluding remarks

The research reported in this thesis has investigated how primary school Natural Sciences teachers implemented formative assessment strategies as means to raise classroom standards and foster higher order cognitive development of learners. Eight themes that emerged from the analysis of data revealed that teachers used formative assessment for various reasons. Data collected from the two teachers observed revealed that several attributes of formative assessment were evident and teachers had good intentions to support learning. This was evident in the lesson plan, teaching and learning activities as well as the assessment tasks they presented. Even though this study was only limited to seven teachers of which two were observed, my recommendation would be that administrators need to afford teachers more support in implementation of formative assessment.

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APPENDICES

Appendix 1: Semi-structured interview questions

1. What are the assessment practices do you employ in your classroom?
   a. How can you describe these practices?
   b. Why do you engage in these practices?
   c. How do these assessment practices affect learning?
2. Can you say that your assessment practices are aligned with your classroom teaching practices? Please explain and give some examples.
3. What do you see as quality learning and how do you use assessment to establish whether sufficient depth and scope have been achieved?
   a. How can you describe these practices?
   b. Why do you engage in these practices?
4. What is your understanding of formative assessment? [Define formative assessment in your own words].
5. How has the use of formative assessment(s) guided your teaching?
6. What benefits do you see in using formative assessment(s)? Please give specific example if you can.
7. In what ways do you communicate with your students about their learning (feedback)?
8. In what ways do you use student work (written and orally communicated) to inform your teaching practice?
9. What kind of growth or lack thereof have you seen in your learners since the implementation of formative assessments(s)?
10. How important are your assessment practices in creating opportunities for learners to learn?
11. What challenges have you experienced when you are using formative assessment? Give specific example if you can.
12. What changes do you feel are most needed in classroom teaching and learner assessment at classroom and school level? Why?
13. What are the possible barriers that would be encountered if these changes would be implemented?

Appendix 2: Sample of the semi-structured interview transcript

1. What are the assessment practices do you employ in your class?
a. How can you describe these practices?
b. Why do you engage in these practices?
c. How do these assessment practices affect learning?

#	Code	Responses
1	T_1	Assessment is one of the things that teachers don't take it serious and yet is very important in guiding one's planning
		Firstly there is the baseline assessment which takes place at the beginning of the year or term depending. There is also informal, formal and diagnostic assessments
a	T_1	Baseline – assess prior knowledge, foundation of planning; informal - classwork; formal - from formal, prepared by informal assessment
b	T_1	I engage in these practices to get learners ready and to arrange learning and planning; verify learner for the content achievement.
c	T_1	The teacher does planning and teaching-learning takes place then the teacher does assessment. This is a cyclic process
1	T_2	It is important to give informal assessment, like classwork, after every lesson or topic to know if the learners really understood the lesson, so that I can also if I have to re-teach the lesson or not.
	T_2	In formal assessment with the guidance of the teacher, it is better when the learner explores and learn by himself
a	T_2	I use informal and formal assessments
b	T_2	Informal assessments are given orally as well as written tests . Formal assessments are only written tests and are used to test learners' level of understanding and how learners comprehend and interpret questions asked during a written exams.
c	T_2	I engage in these practices to allow me gauging yardstick of knowing how to effectively teach each learner as some may excel orally but fail a written exams. Hence I have to teach such a learn a method of coping with written exams by making test on frequent occurrence to familiarize the learner with written exams.
a	T_3	Peer assessment, testing as an assessment, open book assessment, oral assessment, group assessment, examinations
		Peer assessment
		Work in pairs and using the rubric provided, provide feedback (positive only) to the peer concerned. A comment must be added
		Testing as an assessment Learners will learn a selected amount of content and will receive a test based on the content as memory work. Set an amount of work – set the test and mark it according to a memorandum.
		Open book assessment
		The learners have set questions and they need to answer their questions with the aid of their textbooks (textbooks & workbooks).
		Oral assessment
		The learner chooses a topic and prepares a "speech" using aids according to a rubric & checklist provided beforehand. They are given at least a week to

		prepare their oral. A rubric, powerpoint and class discussion is provided. Research may be done in the computer room lesson.
		Group assessment
		The class is grouped heterogeneously and given a section of work to share with the class. There is an expert group and other cooperative learning groups that the class is divided up.
		Examinations
b	T3	A bulk of work is learnt and is assessed under a very structured and strict environments.
		Peer assessment: I select the peer depending on the task. Sometimes it is for guidance/competitive/enrichment.
		Content according to the CAPS document is important for memory and continuation of work
		Open book test forms part of research skills needed
c	T3	Each learner has an individual chance to be heard. They may/may not present in front of their peers depending on their learning styles. Examinations are required by the education department for the competitive
		Peers appreciate being evaluated by peers especially when it is positive
		Open book assessment are more challenging than the rote learning (memory)
		Remembering, research skills, computer skills, using key cards, confidence building
		Learners can learn very effectively from one another as long it is carefully planned. A completed questionnaire indicate efficacy of the learning.
a	T4	Examinations are excellent for self-motivated but for the anxious learners, it is not helpful. CASS assessments are better for the anxious learners.
b	T4	Informal assessment in the form of class works, home works and group work and also formal assessment tasks e.g. tests, examinations and assignments and projects.
c	T4	These types of assessment are the requirements from the WCED/CAPS nationally. Sometimes I engage them when I want to assess whether the learners have fully understood the content, but I seldom do it.
a	T4	The informal assessment practices have no effect at all on the majority of learners, because only a few are doing their individual tasks. Most of them are copying from those few. In formal assessment those who pass become motivated and want to learn more and those who fail they just don't care at all.
b	T5	Informal assessment whereby I check the understanding of children on a given concept through questioning, letting them draw diagrams, presenting a concept. As they learn, discuss I correct them if there is a need and reinforce and motivate them. Formal assessment on concepts taught and checking understanding by giving them a test, revision and mark the work and give feedback to learners
c	T5	These practices help me to see if I am moving together with the learners. To check misconceptions, correct my methods or strategies, improve on my approaches, motivate learners identify individual learning problems, designing individual work to suit different learners, communicate with learners and parents
	T6	These practices affect learning by challenging both the teacher and learners to focus on learning and teaching process. Enable learners to see where they

		are weak and strong and help parents to be involved with their children's work. Directing teachers and informing even stake holders about the general vision of the school and xxx put in place to meet it.
a	T6	Informal assessment and formal assessment, peer and group assessment
b	T6	Informal assessment is the day to day assessment preparing learners for the formal assessment practising activities or short tasks that could be used for formal assessment which will help in the first term reports.
c	T6	To see if the learners understood the subject matter by evaluating them through the assessment and if informal they could not understand I could repeat or redo the content or subject matter, before I can give the formal assessment. It also helps you as a teacher that the learners have followed you in terms of teaching and if not then you can change the strategies or methods of teaching in order for them to understand. It could also help you to ask someone to intervene and assist you as the teacher
a	T7	These assessment help the progression of learning, so that the child can progress to the next grade and be able to work with other learners in group discussion so as to stimulate their self-esteem and leadership skills in learning. It also affect the individual learning which build the confidence when given assessment.
b	T7	Question and answer method; individual activity after each introduced lesson; homework for giving parents and guardians to assist their learners as well; practical lesson and observations; group work but individual reflection
c	T7	Responses are directly link to the order of answers in (a) above: to link the existing knowledge with the new knowledge and to get control of learners' minds; to attract learners' interest during the lesson presentation. During presentation they must be on toes knowing that the activity will follow to test their knowledge; I do this activity to try to engage the parents/guardians and care givers to see what we are doing and also to assist learners to complete what took place in school; Learners learn better when they find out for themselves than to be told. Yes its time consuming, difficult to control but worth value.; because you promote learners to assist each other, you give them group investigations but to make sure that they participated all they must reflect individually may it be verbally or in writing.
		Follow the order of answers in (a):Q&A- It works as a baseline because you immediately identify areas that need more time before moving forward, it also assist to spot the knowledge gap from the previous classes; IA - this method assist to rectify different learner levels in class so that you apply intervention methodologies where necessary, and you start building a learner profile; HW - it depends to different learning backgrounds. Learners acceptable backgrounds benefit while those coming from the poor background its time consuming and waste of time and energy; PW & CO - time consuming but concrete knowledge; GW & IR- promote good working relationships and improve communication between groups of learners and to the teacher and other stake holders as well.

Appendix 3: Lesson observation report form

ADVANCED CERTIFICATE IN TEACHING – NATURAL SCIENCES: SP
LESSON OBSERVATION REPORT FORM

Teacher Name		Grade	
School		Date	
Total Number of learners …	Present: 40 On Register:	Length of period	
Subject: Natural Sciences	Topic:		
Learners with Educational Special Needs – if provided			
Observer Name			

The four domains of an effective lesson are instructional performance, learner/teacher Interactions, classroom environment and assessment. Each domain consists of specific elements that will be stipulated at each domain.

A. TEACHING STRATEGIES		
	Observations	Comments/Recommendations
1. Planning and Preparation	__ Lesson plan establishes lesson and unit objectives __Demonstrate subject matter and curriculum knowledge. __Lesson is at appropriate developmental level of learners _It is responsive to diverse learning needs __Sets challenging and yet attainable expectations __Clearly define structure and reflects appropriate pacing for the allotted time __Lesson plan reflects use of materials that are aligned with the objectives of the lesson __Lesson plan includes strategies to engage learners (see checklist below)	
2. Teaching	_Teacher appears prepared & organized	

	__Materials appear ready & accessible ___ Purpose of instruction is stated & clear ___ Teacher links prior instruction to new ___ Teacher identifies learner misconceptions ___ Teacher identifies learner difficulties _Skills taught appear appropriate ___ Pacing is appropriate ___ Opportunities for students to participate ___ Teacher provide feedback that is timely and specific ___ Teacher modifies instruction as needed (differentiation) ___ Teacher assessment to check understanding ___ Teacher summarizes to review & close	
B. TEACHER/LEARNER INTERACTION		
1. Classroom Management	___ Order is maintained ___ Learner behaviours are positive, interactive ___ Noise level is appropriate __Behaviours are appropriate __Time used efficiently & effectively	
2. Interpersonal Skills	___ Positive rapport shared in classroom ___ Personal needs and / or background of learners addressed ___ Learners receive assistance as needed ___ Learners encouraged to make choices ___ Learners encouraged to act responsibly ___ Teacher responds respectfully ___ Teacher honours learners in classroom	.

	___ Teacher establish a culture for learning, learners show pride in their work	
C. CLASSROOM ENVIRONMENT		
Physical setting	___ Classroom appears orderly & clean ___ Expectations appear to be clear __ Management system appears effective ___ Learners' work is displayed ___ Materials are stored appropriately ___ Environment feels managed & in control ___ Atmosphere is friendly & caring ___ learners appear engaged & learning	
D. ASSESSMENT		
Types of assessment strategies	___ evidence of diagnostic assessment ____ evidence of formative assessment ____ evidence of summative assessment	
SUMMARY:		

The Schools Development Unit offers a supportive service to the teachers under the premise that effective instruction requires a high level of cooperation and understanding between lecturer and teacher. The formal observation report is intended to be used as a tool toward excellence in teaching. It will include a critique of the lesson observed and where necessary, suggestions for the improvement of instruction. After observation has been completed, the report becomes a part of the teacher's personal document.

Observer's Signature: _____ Date:_____

Teacher's Signature:_____ Date:_____

Instructional Strategies Checklist

Knowledge of Instructional Strategies and Representations		#
Types of Language Devices		
Explanation	Metaphors	
	Analogies	
	Similies	
Examples	Related	
	Similar situation	
	Dissimilar situation	
Narrative	Stories/ Anecdotes	
	Biography	
Illustration		
Mnenomic device		
Questioning	Recall/factual	
	Attention focusing questions	
	Problem-posing	
	Action	
	Reasoning	
	Comparison	
	Rhetorical	
	Checking for understanding	
Argumentation	Logic	
	Induction	
	Deduction	

Collaborative learning techniques	Think-Pair-Share	
	Reciprocal Teaching	
	Think-Aloud Pair Problem Solving (TAPPS)	
	Group Grid	
	Group Writing Assignments	
Feedback loops		

Appendix 4: Analytical memo 1 - Semi-structured interview

Category/themes	Extract	Reference/source
I: Improving planning and teaching	Assessment is one of the things that teachers don't take it serious and yet is very important in guiding one's planning… I engage in these practices to arrange learning and planning." "The teacher does planning and teaching-learning takes place then the teacher does assessment. This is a cyclic process.	T_1:IQ_1
	These practices help me to see if I am moving together with the learners. To check misconceptions, correct my methods or strategies, improve on my approaches, motivate learners identify individual learning problems, designing individual work to suit different learners, communicate with learners and parents.	T_6:IQ_{10}
II: Scaffolding individual learning	It is important to give informal assessment, like classwork, after every lesson or topic to know if the learners really understood the lesson, so that I can also if I have to re-teach the lesson or not.	T_2:IQ_1
	In formal assessment with the guidance of the teacher, it is better when the learner explores and learn by himself.	T_2:IQ_1
	Formative assessment is the type of assessment whereby the learners are assessed while the teacher is teaching, it is part of the lesson whereby a feedback is given to learners so that the teacher can be able to adjust his/her teaching practices based on feedback.	T_4:IQ_4
	Formative assessment is when you check the understanding of learners as you teach them. You diagnose their misconceptions and redirect them before the end of the task. On the spot to direct and guide them.	T_5:IQ_4
	… be able to work with other learners in group discussion to stimulate their self-esteem and leadership skills in learning. It also affects the individual learning which build the confidence when given assessment.	T_7:IQ_1
	They help me to come up with activities so that I can help them to close the gap my learners have.	T_7:IQ_5
III: Preparing learners for test and examinations	Formative assessments are yardsticks to assess where learners are in their ability to understand test questions asked and their ability to answer them.	T_2:IQ_4
	Learners can be asked to mark their work and identify their mistakes and this can help them when writing the test.	T_2:IQ_4

	I engage to these practices so that I can teach learners who may be strong in oral exams but fail written exams so that they can learn a method of coping with written exams by making tests on frequent occurrences to familiarize learners with written exams.	T_3:IQ_1
	Informal assessment is the day to day assessment preparing learners for the formal assessment practising activities or short tasks that could be used for formal assessment which will help in the first term reports.	T_5:IQ_1
IV: Teaching and learning	It is important to give formative assessment during discussion to really know if learners are with you or understand. This help me to re-teach it again.	T_2:IQ_6
	My learners' performance gives me an indication of my teaching.	T_3:IQ_6
	They make them keen to learn more.	T_3:IQ_1
	Formative assessment guides my teaching only as far as learners understanding of the subject matter goes. My teaching methods are more guided by the type of learners I have and after I have assessed them I adapt my teaching style to get learners engaged.	T_2:Q_5
	… I plan my assessments, informal and formal that I would like to do in the section of work. My class teaching is then clearer to the learners.	T_3:IQ_2
	… Sometimes you might think your teaching is good, but when you assess you get the opposite of what you expected.	T_4:IQ_2
	Formative assessment guide my teaching by directing me and telling me if learners are understanding the concepts at hand. Helps me to adjust the method, approach or even to divert the whole lesson to something of greater importance they should know before the concept at hand.	T_5:IQ_5
	Children's work tells me if they get the concept or not. By evaluating their work, I also evaluate my approaches. If they get the concept right, it means the approach used is a good one and can be used again and the opposite is true.	T_5:IQ_8
	These practices help me to see if I am moving together with the learners. To check misconceptions, correct my methods or strategies, improve on my approaches, motivate learners identify individual learning problems, designing individual work to suit different learners, communicate with learners and parents.	T_6:IQ_{10}
V: Reporting and learner promotion	To see how many 1 – 7 scale learners, verification of results, improvement, motivation.	T_1:IQ_5
	"Formative assessment is assessment that is recorded – for report usually at the end of the year.	T_1: IQ_4

	Formative assessment is the one that leads learners to be promoted to the next grade, or it shows the parents the progress of the learner during each term during the year. It gives full report of the learner's progress in school.	T_6:IQ_4
	These assessments help the progression of learning, so that the child can progress to the next grade…	T_7:IQ_1
	Those are the forms of assessment that are used to measure an individual learner performance and to attach the status of progression e.g. not ready to progress or progress with support etc.	T_7:IQ_4
VI: Quality learning	Quality learning is when learners are interacting. They are responding to the subject matter in a meaningful way, they ask questions. They are not afraid to give their opinions. They are learners that are not only recipients they are participants. This indicate to me whether I achieved sufficient depth and scope.	T_2:IQ_3
	Quality learning is when all learners engage and feel a sense of achievement" "I mean when learners understand and pass well a piece of work they were doing." "Critical thinking is essential and this is assessed via questioning techniques and worksheets and giving them many opportunities.	T_3:IQ_3
	I use these tasks to clearly see the extent of the learning gained by the learners beside the oral questions or classwork given to them. It was used to assess the deep understanding of the learners regarding the concepts taught.	T_4:IQ_4
	Quality learning is when learners are able to understand the content and are able to display that on the different assessment strategies you engage them in. You engage them because you want to assess if the set of objectives of the lesson have been reached or if the skills have been acquired.	T_4:IQ_3
	I engaged in these practices because I want to know the progress of my learners not just in the cognitive level but also in skills and values.	T_7:IQ_4
	Quality learning is when learners are motivated to get new knowledge using hand-on or practical work activities, interacting with the environment and the ability of learners to see their strength and weaknesses. Even teachers to critique themselves as to improve their approaches.	T_5:IQ_3
	… Questioning should vary to cover all the learners in the class even those who are slow. There should be different types of questions, lower order, and the higher order depending on the level your learners are at.	T_6:IQ_3
	By using the Bloom's taxonomy order of questioning and assessment. To oversee all learners' abilities and also to know where to assist or give support.	T_7Q_3

Appendix 5: Permission letter

Western Cape Government
Education

Tel: +27 021 467 9272
Fax: 0865902282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20150629-830
ENQUIRIES: Dr A T Wyngaard

Dear Ms Nomvuyo Mgoqi

Research Proposal: an exploration of formative assessment in environmental learning processes in primary school natural sciences classrooms

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from 01 July 2015 till 30 September 2015
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to: The Director: Research Services

Western Cape Education Department
Private Bag X9114
CAPE TOWN
8000

We wish you success in your research.
Kind regards.
Signed: Dr Audrey T Wyngaard
Directorate: Research
DATE: 30 June 2015

Lower Parliament Street, Cape Town, 8001 Private Bag X9114, Cape Town, 8000
tel: +27 21 467 9272 fax: 0865902282 Employment and salary enquiries: 0861 92 33 22

Appendix 6: Consent forms

Appendix 6a: School consent form

Schools Development Unit
University of Cape Town, Private Bag,
Rondebosch, 7701

Dear Principal
I am a registered full time Masters in Environmental Education student at Rhodes University in South
Africa. The purpose of the study is to explore how Natural Sciences teachers understand and use formative assessment in their classroom practices and how does this reflect depth and quality in learning process. These teachers are enrolled in the Advanced Certificate in Teaching Natural Sciences: Senior Phase (ACT: SP) programme at the university of Cape Town.
The study will involve classroom observations, analysis of documents like lesson plans, test questions, assessment tasks designed by the teachers and some learners' work. For this reason, I am asking permission to conduct the above mentioned, data gathering procedures. During class observations, as the researcher I will focus on activities that occur in the classroom not on the learners. Therefore, this endeavour will not harm in any way learners in classes that will be observed. Ethical issues such as confidentiality, right to privacy, dignity, and honesty will be maintained. No names will be revealed.
The approval letter, and analysis results will be kept safe. All the data and documents used during the conduct of the study will be disposed few years after the thesis of the researcher is finalised. Participation in this study is completely voluntary; therefore, participants are free to withdraw from the study at any time without moral obligation to the researcher, the Rhodes University or the Cape Town University. Furthermore, you as the principal of the school and the teacher participant have the right to verify the data to be included in the final thesis.
If the school is willing to participate in this study, please sign the consent letter in the space below,
Principal's signature _____ Date_____

Your positive regard on this matter will be highly appreciated.
Yours truly,
Nomvuyo Mgoqi

Education Specialist (Sciences)
ACT Natural Sciences stream convener
(W) 021-6503988
Nomvuyo.mgoqi@uct.ac.za
071 0339 888
Should you wish to know more about the study, please feel free to contact my supervisor at:
Dr Ingrid Schudel, 046-603 8389, i.schudel@ru.ac.za

Appendix 6b: Teachers' consent forms

Schools Development Unit

University of Cape Town, Private Bag, Rondebosch, 7701
4th Floor, Neville Alexander Building 11,
University Avenue – South Entrance,
Upper Campus, Rondebosch, 7701

Tel: +27 (0) 21 650 3584 Fax: +27 (0) 21 650 3569
Internet: www.sdu.uct.ac.za

Schools Development Unit
School of Education
10th Anniversary **2000 - 2010**

Dear

I am a registered full time Masters in Environmental Education student at Rhodes University in South Africa. The purpose of the study is to explore how Natural Sciences teachers perceive and use formative assessment in their classroom practices and how does this reflect depth and quality in the learning process. The findings of this study will inform the development of the assessment module in the Advanced Certificate in Teaching Natural Sciences: SP programme.

The study will involve interviews, classroom observations, analysis of documents like lesson plans, test questions, teacher made assessment tasks and learners' work. During class observations, the researcher will focus on the activities that occur in the classroom not on the learners. Therefore, this endeavour will not harm in any way learners in classes that will be observed. Also, confidentiality of the information obtained is assured, as there will be no other individual who have access on them except the researcher and her supervisor.

This approval letter, and analysis results will be kept safe. All the data and documents used during the process of the study will be disposed few years after the thesis of the researcher is finalised. Participation in this study is completely voluntary; therefore, participants are free to withdraw from the study at any time without moral obligation to the researcher, the Rhodes University or the Cape Town University. Ethical issues such as confidentiality, right to privacy, dignity, and honesty will be maintained. Your name will not be revealed anywhere in the study.

If you agree to participate in this study, please sign the consent letter in the space below,

Signed _____ Date 31 August 2015

Your positive regard on this matter will be highly appreciated.

Yours truly,
Nomvuyo Mgoqi

Mgoqi

Education Specialist (Sciences)
ACE Natural Sciences stream convener
(W) 021-6503988
Nomvuyo.mgoqi@uct.ac.za
071 0339 888

"Our Mission is to be an outstanding teaching and research university, educating for life and addressing the challenges facing our society."

Appendix 7: Mr Tall Lesson observations

Appendix 7a: Mr Tall's Lesson plan

NATURAL SCIENCES AND TECHNOLOGY LESSON PLAN
GRADE: 5 TERM: 3 SPECIAL EVENT:_____
WEEK: 5C DATE: 17 – 21 August 2015

KNOWLEDGE STRANDS	LIFE & LIVING AND STRUCTURES OR PROCESSING	MATTER & MATERIAL AND STRUCTURES/ PROCESSING	ENERGY AND CHANGE AND SYSTEMS & CONTROL	PLANET EARTN AND BEYOND AND SYSTEMS & CONTROL

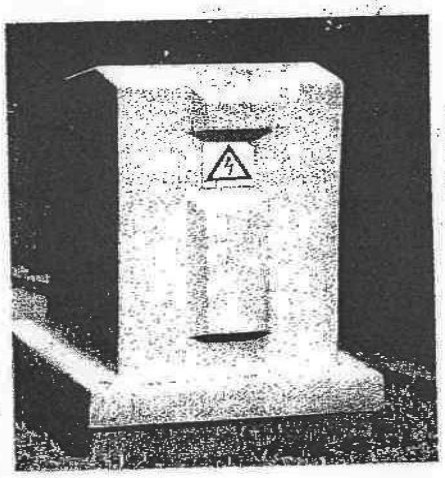
TOPIC AND SKILLS FOCUS APPLICABLE FOR EACH SPECIFIC AIM					
SPECIFIC AIM 1 Doing Science and Technology	SPECIFIC AIM 2 Understanding and connecting ideas			SPECIFIC AIM 3 Science, Technology and Society	
Learners should be able to complete investigations, analyse problems and use practical processes and skills in designing and evaluating solutions.	Learners should have grasp of scientific, technological and environmental knowledge and be able to apply it in context.			Learners should understand the practical use of Natural Sciences and Technology in society and environment and have values that make them caring and creative citizens	
VOCABULARY/CONCEPTS: Energy and Electricity (Main electricity)/(Safety with electricity)					
RESOURCES:	Pictures	Textbooks **X**	Articles	Instruments	Worksheet **X**
	Equipment	Materials	Fieldwork	Board **X**	Audio/visual
ASSESSMENT: *Please tic*		FORMAL:		INFORMAL:	
Rubric	Observation	Oral	Presentation	Investigate	Test
Review	Written **X**	Practical	Research		

	EDUCATOR ACTIVITY		LEARNER ACTIVITY
EDUCATIONAL ACTIVITIES SPLIT INTO PERIODS	1	Explain how energy in a power station can be fuel such as coal.	Write about how energy in a power station can be fuel and give own examples
	2	Explain the concept of safety with electricity.	Learners give examples of unsafe electricity scenarios. Read case study. Complete exercise.
	3	Recap safety with electricity. Explain what safety precautions should be taken when using electricity.	Write down steps on what safety precaution should be taken when using electricity. Complete exercise.

Appendix 7 b: Mr Tall's teaching and learning activities – warning signs

Warning signs

The sign you must know and obey is the one that marks high voltage installations. They are (or should be) on any installation where the voltage is high enough to be dangerous. The right hand photograph shows the sign and the left hand photograph shows a household electrical box bearing the high voltage sign.



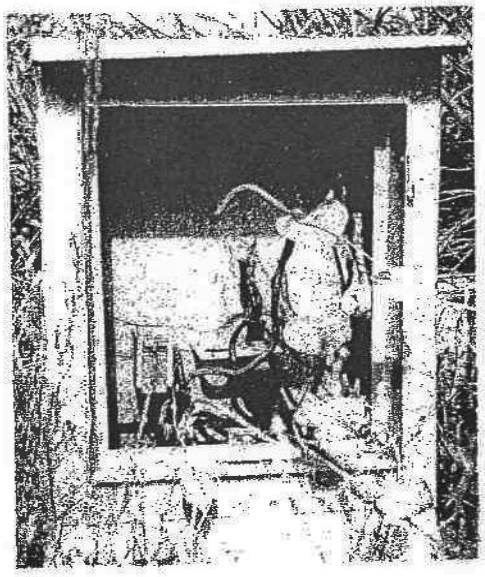
Take this sign seriously, if you ignore it you might find yourself being electrocuted.

Keep away from anything with this sign somewhere on it.

sulation is there to keep the current where it longs: in the circuit, not flowing through you.

ever damage the insulation on electric wires and eep away from installations where the insulation as been damaged by somebody else (like maybe ble thieves).

ne photograph on the right shows an electrical ox with damaged insulation. Sometimes nobody tually damages the insulation – it just gets old nd cracked and falls off.



Remember:

Electricity is ***dangerous to humans***. There are two ways electricity can harm you.

By burning you.

By stopping your heart.

Appendix 7b Mr Tall's teaching and learning activities – Illegal connections

Case Study

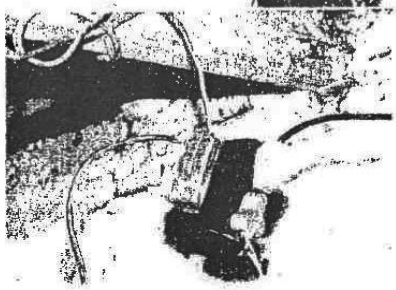
Illegal connections

Overloading by many people, especially with unplanned, illegal connections, can cause the national supply grid to fail. It may be simply a case of resetting the circuit breaker, but often the overload causes fires. These destroy very expensive equipment which may take days or even weeks to replace. Of course this adds to the cost of electricity - so we all pay.

At home it is just an inconvenience – you simply unplug some appliances and reset the circuit breaker. On the national grid it can be disastrous.

It takes much longer to restore power and until that happens, people can be stuck in lifts, miners can be trapped down mines, patients in hospitals can die and businesses can lose income.

An illegal connection is one of the ways in which the national grid can be overloaded.



People who connect illegally to the grid don't pay for their electricity. That means that honest people like you and me end up paying their bills for them. This means that not only are these illegal connections a form of theft, but they are stealing from us. You and I are the victims!

Questions

) What is the function of the national grid?

2) What happens if the grid gets overloaded?

3) Name two negative impacts that can happen to people if the national grid fails.

4) Why do you think we have load shedding in South Africa?

Appendix 7c Mr Tall's teaching and learning activities – Mrs Kokoropo's family uses electricity

Examine how Mrs Kokoropo's family uses electricity

Your work

Study the drawing of Mrs Kokoropo's house in Figure 4 below.

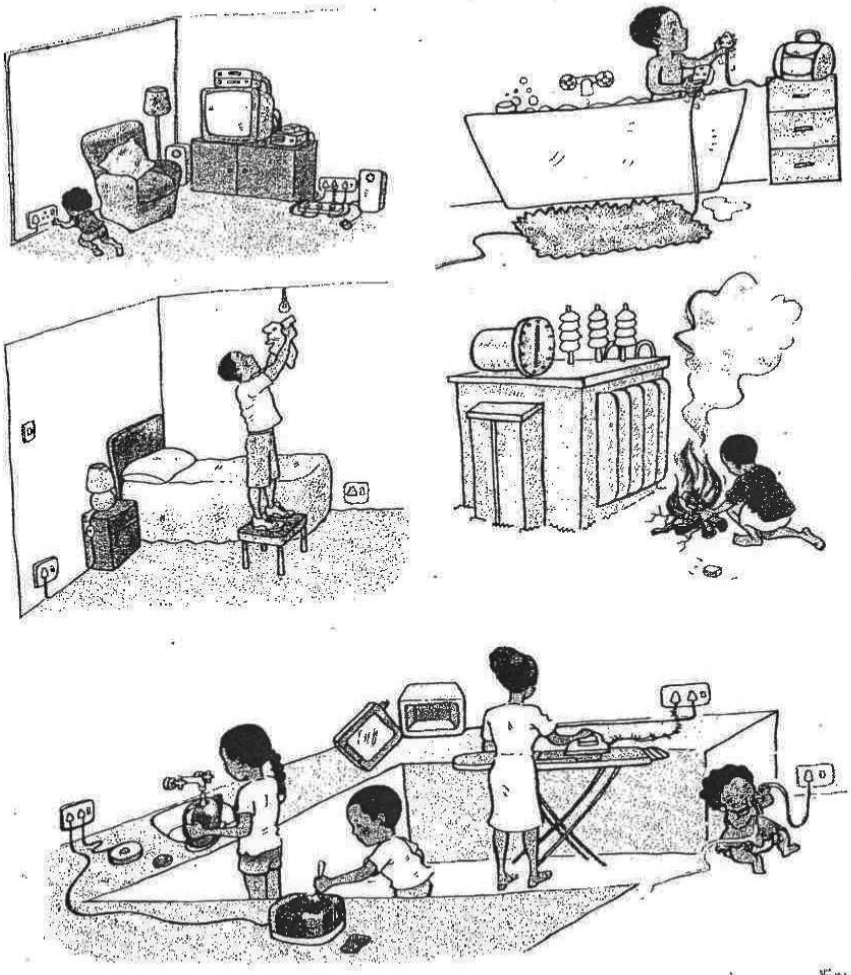


Figure 4 Mrs Kokoropo's house

1 **Identify** things that her family are doing that will prevent an electric fire or a shock. Make a **list** of these things.
2 Identify things that her family is doing that could cause an electrical fire or electric shock. Make a list of these things.
3 Write down what they should be doing next to each thing that could cause an electrical fire or an electric shock.
4 Report back to the class when you have finished and share your answers and suggestions.

Exam words

study – to carefully look at something

identify – to recognise something; to find something

list – to write down the facts one below each other

Appendix 7c: Mr Tall's assessment task

ACTIVITY 12 **Make a poster about the safe use of electricity**

Make a poster to show other people how to use electricity safely. You will need to decide who your poster is for and where you will display it. For example, it may be a poster to put up at school, or at home, or in a community hall. Include the information that you think is most useful for your audience. Use words and pictures.

Electricity outside the home

1. Stay out of electrical substations.
2. Do not touch, or go near, any electrical transmission lines, even if they have fallen on the ground.
3. Do not play or make a fire underneath power lines.
4. Do not carry long objects underneath power lines.
5. Never climb electrical pylons.

Electrical cords

1. Electrical cords are made with thick plastic that covers the metal wires that carry electricity. There should be no metal wires showing from the plug to the appliance.
2. Do not use damaged cords. Ask an adult to replace the cord.
3. Heat can damage the plastic coating on the cord. Keep cords away from hot stoves and other hot surfaces.
4. Do not put electrical cords under carpets or rugs, or through hinges and the back of doors.
5. Do not mend, or join, broken cords with tape.
6. Do not put electrical cords where a person can trip over them.

Water and electricity

1. Never use an electrical appliance near water. This includes the bathroom. An electric lawnmower must not be used on wet grass.
2. Never touch an electrical appliance with wet hands.
3. Unplug an electric kettle or iron before putting water in it.
4. Never use water to put out a fire close to, or in, an electrical system. Use sand or a dry chemical fire extinguisher instead.

UNIT 3

Safety with electricity

Electricity is dangerous. If electrical wires and appliances are damaged or not connected correctly, they can cause fires. They can also give people electric shocks. If a lot of electricity goes through a person's body, the person may die.

There are three important facts to know about electricity:

- Electricity transmission lines and wires in substations carry large amounts of electricity.
- Electricity does not go through plastic and rubber.
- Electricity easily goes through water, people's bodies and metal.

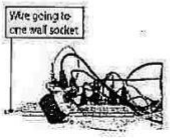


Figure 17 Too many appliances are plugged in here.

Figure 18 An appliance with a damaged cord must not be used.

How to use electricity safely

Plugs and wall sockets

1. Do not plug too many appliances into one wall socket. It can cause a fire, and/or overload the system.
2. Make sure that the switch is off before taking a plug out of the wall socket.
3. Hold the sides of a plug to remove it from a wall socket, do not pull it by the cord.
4. If a wall socket is not used, make sure the switch is in the 'off' position.
5. Wall sockets are only for plugs. Do not put your finger or a wire into the holes in a wall socket.

Electrical cords

1. Electrical cords are made with thick plastic that covers the metal wires that carry electricity. There should be no metal wires showing from the plug to the appliance.
2. Do not use damaged cords. Ask an adult to replace the cord.
3. Heat can damage the plastic coating on the cord. Keep cords away from hot stoves and other hot surfaces.
4. Do not put electrical cords under carpets or rugs, or through hinges and the back of doors.
5. Do not mend, or join, broken cords with tape.
6. Do not put electrical cords where a person can trip over them.

Water and electricity

1. Never use an electrical appliance near water. This includes the bathroom. An electric lawnmower must not be used on wet grass.
2. Never touch an electrical appliance with wet hands.
3. Unplug an electric kettle or iron before putting water in it.
4. Never use water to put out a fire close to, or in, an electrical system. Use sand or a dry chemical fire extinguisher instead.

Electricity outside the home

1. Stay out of electrical substations.
2. Do not touch, or go near, any electrical transmission lines, even if they have fallen on the ground.
3. Do not play or make a fire underneath power lines.
4. Do not carry long objects underneath power lines.
5. Never climb electrical pylons.

Figure 19 The electricity in the cables in substations is very strong. Stay away from them.

Figure 20 A warning sign outside a substation.

ACTIVITY 11 Discuss the safe use of electricity

1. Read about how to use electricity safely on pages 138–139.
2. For each point, explain to your partner why it is important.
3. Discuss the safe use of electricity with your class.

ACTIVITY 12 Make a poster about the safe use of electricity

1. Make a poster to show other people how to use electricity safely. You will need to decide who your poster is for and where you will display it. For example, it may be a poster to put up at school, or at home, or in a community hall. Include the information that you think is most useful for your audience. Use words and pictures.

Key concepts
Electricity can be dangerous. It must be used carefully.
There are things we can do to use electricity safely.

Figure 21 Never climb any poles or pylons that have electrical cables.

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Unit 3: Safety with electricity

Teaching guidelines

Show the learners pictures of electricity warning signs that are used in South Africa. They should be able to recognise these signs so that they do not go near dangerous areas like substations or where transformers are kept.

Activity 11: Discuss the safe use of electricity (Pairs)

Answers

1 and 2. Learners should work in pairs. Ask them to read about how to use electricity safely on pages 138–139 of the Learners' Book.

3. Learners to discuss safety with electricity amongst themselves.

Activity 12: Make a poster about the safe use of electricity (Individual)

Answers

1. Learners' posters should display at least four of the following elements:
   - Do not plug too many appliances into one wall socket.
   - Make sure that the switch is off before taking a plug out of the wall socket.
   - Hold the sides of a plug to remove it from a wall socket, do not pull it by the cord.
   - If a wall socket is not used, make sure the switch is in the 'off' position.
   - Wall sockets are only for plugs. Do not put your finger or a wire into the holes in a wall socket.
   - Electrical cords are made with thick plastic that covers the metal wires that carry electricity. There should be no metal wires showing from the plug to the appliance.
   - Do not use damaged cords.
   - Keep cords away from hot stoves and other hot surfaces.
   - Do not put electrical cords under carpets or rugs, or through hinges and the back of doors.
   - Do not mend or join broken cords with tape.
   - Do not put electrical cords where a person can trip over them.
   - Never use an electrical appliance near water. This includes the bathroom. An electric lawnmower must not be used on wet grass.
   - Never touch an electrical appliance with wet hands.
   - Unplug an electric kettle or iron before putting water in it.
   - Never use water to put out a fire close to or in an electrical system. Use sand or a dry chemical fire extinguisher instead.
   - Stay out of electrical substations.
   - Do not touch, or go near, any electrical transmission lines, even if they have fallen on the ground.
   - Do not play or make a fire underneath power lines.
   - Do not carry long objects underneath power lines.
   - Never climb electrical pylons.

Support for this unit

Make use of fun rhymes or songs to teach the learners emergency telephone numbers.

Appendix 8: Mrs Nyoka's Lesson observations

Appendix 8a: Mrs Nyoka's lesson plan

LESSON PLAN Grade 7 2016

Key Questions	South Africa is the third most biodiverse country in the world. South Africa is a hotspot of global conservation which is a concern because it means that our plants and animals species are endangered. **What can we do to prevent this taking place?**	
Prior knowledge	Biodiversity is taught in Grade 6. Life and Living in Grade 7 introduces the 3 different spheres within the biosphere.	
Resources	Hangman with the Title of Biodiversity, Pictures from magazines, YouTube video clip, PowerPoint, Textbook "Step Ahead Series", Worksheets and rubric	
Informal assessment	What is the teacher doing?	What are the learners doing?
	Lesson 1: The teachers will play a game using the letters to work out the word BIODIVERSITY. Discuss some of the plants and animals under the letters of the title. Show the YouTube video clip to the learners on Biodiversity. Read the information provided about the different variety of plant and animal species Lesson 2: Hand out the instructions for the project on Biodiversity. Discuss the rubric in detail and the layout. Read the textbook information provided	Lesson 1: The learners will place their pictures of animals and plants under each letter of the word BIODIVERSITY. Learners will observe the video and make notes as they watch it. Gather further information. Lesson 2: The learners will read all the instructions provided and ask questions that require further explanations. Start to read aloud and work on the project in the class.
Assessment activity	The CAPS 50 mark, project provided with a rubric.	
Extension ideas/Challenges	What can learners do to prevent extinction of our plant and animal species?	

Appendix 8b Mrs Nyoka teaching and learning activities – textbook extract

step ahead SERIES

BATELEUR BOOKS (PTY) LTD

7

Natural Sciences

BIODIVERSITY

Biodiversity means the range of variety of plants and animals in an ecosystem. An ecosystem with high biodiversity means that it contains many different kinds of plants and animals.

PRESERVING BIODIVERSITY

Preserving biodiversity includes maintaining varied landscapes within ecosystems, protecting endangered species, and preserving the wild crop ancestors of our domestic crops.

When habitats are destroyed and species become extinct, there are ecological consequences that directly affect our quality of life. Scientists have worked out that the biggest threat to biological diversity is human overpopulation. Overpopulation is not only a problem of overcrowding, but also of overusing our resources, such as water, wood (plants), land and so on. Since plants capture energy from the sun, loss of plant life means that less energy is available to support other organisms throughout the ecosystem.

Loss of biodiversity means that the earth will not be able to sustain as much life as it did before. Protecting biodiversity has become one of the main aims of conservation.

Since the 1970s ecologists have realised that humans are causing species extinctions at an alarming rate. Read this article about studies done by the World Wildlife Fund:

A study by the World Wildlife Fund (WWF) warns that if extinctions continue at the current rate, by the middle of the 21st century the oceans will be empty of marine life, forests will be gone and 25% everywhere. These statistics show some of the worrying things that have happened since 1970:

- More than a third of the natural world has been destroyed by expanding human civilization since 1970.
- Over-fishing of the oceans has produced the collapse of the North Atlantic cod. In 1970, there were an estimated 264 000 tons of the fish. Today, that number has dropped by 80%, down to only 60 000 tons. That number is expected to keep going down.

- The forest cover of our planet has shrunk by 12 percent.
- Fresh water ecosystems have been reduced by 55 percent.
- The world's tiger population is down 95%.
- There are only about 3 000 black rhinos left.

Appendix 8c Mrs Nyoka's teaching and learning activities - Notes

An overview of South Africa's biodiversity

Plants:
- More than 20 300 species of flowering plants.
- One of six most significant concentrations of plants in the world, is the Cape's fynbos vegetation.

Mammals:
- 243 mammal species are found in South Africa.

Birds:
- 800 different bird species are found in South Africa.

Reptiles and amphibians:
- 370 species of reptiles and amphibians occur in South Africa.

Fish:
- 220 fresh water and more than 2 000 marine water fish species are found in South Africa.

Insects:
- 80 000 known species occur in South Africa.

Describing the conservation status of a species

Extinct:
- a species for which there is a historical record, but which no longer exists in a particular area

Endangered:
- a species in danger of extinction, and whose survival is unlikely if the factors causing its decline remain

Vulnerable:
- a species which it is believed will move into the endangered category if the factors causing its decline remain

Rare:
- a species with small populations, which are not yet vulnerable or endangered, but which are at risk

Threatened:
- the term commonly used as a collective description for species which are endangered, vulnerable or rare

Endemic:
- when some species are restricted to one region and occur nowhere else.
- a threatened endemic species is a conservation priority

WHAT CAN YOU DO?

- demands for goods and services place pressure on the environment - the less we use, the less severe the pressure
- when a conservation issue rears its head, make your voice heard - draw up a petition, contact your local MP, write to the Department of Environment Affairs and liaise with your newspaper
- support a conservation organization

The South African Bill of Rights

Everyone has the right:

- to an environment that is not harmful to their health or well being
- to have the environment protected for the benefit of present and future generations

DEFINITIONS:

biosphere:
- part of the earth containing living organisms

community:
- includes animals and plants of the same kind as well as many other kinds of plants and animals

ecosystem:
- living and non living parts of an area that interact with one another

ecology:
- the study of the relationships between a community of plants and animals interacting with each other and their environment

habitat:
- the environment where a plant or animal lives

species:
- biological grouping that contains individuals that resemble one another

niche:
- the functional role of a species in a community

BIODIVERSITY

What is biodiversity?

Biodiversity describes the variety of life in an area, which includes...

- the number of different species
- the genetic wealth within each species
- the interrelationships between the different species, and
- the natural areas where they occur

Biodiversity in South Africa

An immensely rich species diversity is found in South Africa. With a land surface area of 1,1 million km^2, (just 1% of the earth's total land surface) South Africa contains almost 10% of the world's total known bird, fish and plant species, and over 6% of the world's mammal and reptile species. South Africa is the third most biodiverse country in the world.

What makes this biodiversity possible?

South Africa has...

- a wide range of climatic conditions, and
- many variations in topography (e.g. narrow coastal plain, steep escarpment and large plateau

These 2 factors give rise to broad vegetation and climatic regions, each with their associated animal life.

Threats to South Africa's biodiversity

Our natural wealth is threatened by growing human populations and their demands on the environment through economic development, agriculture and urbanization. Invasive alien vegetation and the trade in wildlife also add to the problem.

RESEARCH TASK: Use the textbook, *Step Ahead Series* pages 83 to 86 to complete the task.

Due date: _____ **50 marks**

1. What is biodiversity?
2. When is an area regarded as having a high biodiversity?
3. What is meant by preserving biodiversity?
4. Why is it so important to preserve our natural plants?
5. Why has it become so important to be serious about protecting biodiversity?
6. Why is the South African biodiversity regarded as being so important?
7. List at least 5 ways in which humans have negatively affected the earth's biodiversity.
8. List at least 4 ways in which you can help with preserving biodiversity.

Appendix 8d Mrs Nyoka Assessment task and marking rubric

RESEARCH TASK: Use the textbook, Step Ahead Series pages 83 to 86 to complete the task
Due Date:_____ 50 marks

1. What is biodiversity?
2. When is, an area regarded as having a high biodiversity?
3. What is meant by preserving biodiversity?
4. Why is it so important to perverse our natural plants?
5. Why has it become so important to be serious about projecting biodiversity?
6. Why is the South African biodiversity regarding biodiversity regarded as being so important?
7. List at least 5 ways in which humans have negatively affected the earth's biodiversity.
8. List at least 4 ways in which you can help preserving biodiversity.

Rubric: Biodiversity Activity (50 marks)

CRITERIA	0 – 3	4 – 5	6 – 7	8 – 10
Knowledge of biodiversity • Definition • Biodiversity within a specific region	Very little understanding of biodiversity is evident	Sufficient information is provided	Compiled with all requirements; recalls meaningful information	An excellent interpretation of the definition
Preservation of biodiversity in South: • Why does it need to be preserved?	Very little information is provided – more input is required	Awareness is evident but very little detail is explained	Shows a meaningful understanding of biodiversity	An excellent understanding of the preservation of biodiversity
Importance of biodiversity in South Africa	Lack of information – more detail is required	An awareness is evident but lacks depth	Have a very good grasp of the importance of biodiversity	An excellent insight into biodiversity is displayed
Personal contribution: • Recognition of human effect on biodiversity • Possible solutions	No real effort has been made regarding the importance of this aspect	Has shown some involvement and briefly grasps the situation	Mostly capable of explaining the importance of human involvement in the situation	All five ways of negative impact and all four human contribution are evident
Presentation: • Neatness • Spelling and punctuation • Pictures, labels and extras	Lack of information. Not neat enough Too many errors Pictures and extras are lacking	Spelling & punctuation requires attention – affects presentation Some extra effort made	A good presentation, well organised research Thorough care is taken Use of pictures a& extras is meaningful	A stunning, well researched activity without any errors Pictures & extras compliment the presentation

Appendix 9 Coding Scale for the dimensions (strategies) of Formative Assessment

Dimension	Level 1 Beginning	Level 2 Developing	Level 3 Progressing
Learning goals Clarifying and sharing learning intensions	The lesson is presented in isolation without connecting to previous or future learning. The teacher only presents an agenda for the day or lesson activities. Learning goals are expressed in language that is not accessible to learners (using language of the CAPS)	Lesson is presented with only isolated references made to previous or future learning. The teacher present the learning goals at the beginning of the lesson but does not return to them in a meaningful way throughout the lesson	The lesson is clearly presented in terms of previous or future learning. A broader sequence of learning is identified and the teacher shares where the current lesson fits within the learning sequence. The learning goals focus on what the learners should know and understand by the end of the lesson. The teacher presents the learning goals by writing them on the board, and makes verbal or direct reference to the learning goals throughout the lesson.
Criteria for success Clarifying and sharing the criteria for success to learners	The teacher does not share criteria for success with learners. The criteria for success are expressed in language that is not accessible to learners.	The teacher shares criteria for success with learners. The teacher does not provide a way for learners to internalize or use the criteria effectively (e.g. develop the criteria themselves, explanations, time or support to use them), resulting in no learner engaging with the criteria in a meaningful way.	The teacher shares the criteria for success with learners. The teacher provides a way for the learners to internalize/use the criteria effectively. The process ensures that learners engage with the criteria in meaningful ways that support learning throughout the lesson, resulting in the majority of learners engaging in and benefiting from the process.
Tasks and activities that elicit evidence of student learning	The teacher uses tasks or activities that are not connected to the learning goals or will not provide evidence of	The teacher uses tasks or activities that are loosely connected to the learning goals and will provide limited evidence of learner	The teacher uses well-crafted tasks and activities that are connected to the learning goals and will provide evidence of learner

Tasks and activities during the lesson provided opportunities for the teacher to collect evidence of learner understanding in relation to the learning goals	learner progress toward those goals. The evidence collected cannot be used to make meaningful inferences about the class's progress on intended learning outcomes and to adapt/continue teaching.	progress toward the learning goals. The teacher misses multiple critical opportunities to make inferences about learner progress and/or adapt/continue teaching as planned.	progress toward those goals. The teacher uses learners' responses to make inferences about learners' progress and adjust/continue teaching as planned.
Questioning strategies that elicit evidence of student learning Use questioning strategies to collect evidence of learner thinking in relation to the set goals. Collect evidence from most learners systematically.	The teacher asks very few questions designed to assess learner progress. The teacher provides inadequate wait-time and/or often answers own questions. The questioning strategies provide evidence from only few or same learners in the class. The evidence collected cannot be used to make a meaningful inference about the class's progress on intended learning outcomes and to adapt/continues teaching as planned.	The teacher asks some questions at appropriate points to assess learner progress. The teacher inconsistently provides adequate wait-time to allow learners to engage with the questions. The teacher sometimes answers own questions. The teacher inconsistently uses questioning strategies to collect evidence of learning from more learners, but implementation may not be consistent or structured in a beneficial way. The teacher misses multiple critical opportunities to make inferences about learner progress and/or adapt/continue teaching as planned.	The teacher asks questions at appropriate points to assess learner progress. The teacher provides the appropriate wait-time to allow all learners to engage with the questions. The teacher uses effective questioning strategies to collect evidence of learning from all learners in systematic ways. The teacher effectively uses learner responses, probing for more information as necessary, to make inferences about learner progress and adjust/continue teaching as planned.

Feedback loops during questioning Providing feedback to deepen learner thinking	The teacher asks none or very few questions designed to encourage classroom discourse during the lesson. The teacher asks questions from learners, but discourse focuses on a statement of correct or incorrect rather than a deeper/meaningful exploration of ideas.	The teacher asks questions designed to encourage classroom discourse at a few points during the lesson. The teacher only occasionally builds on learner responses or encourages learners to build on each other's responses. Occasional feedback loops are short and often end abruptly and do not allow a full exploration of ideas and concepts.	The teacher asks questions designed to encourage classroom discourse at multiple points during the lesson. The teacher and learners frequently build on other learners' responses, clarify learner comments, push for more elaborate answers, or engage more learners in thinking about the problem. Feedback loops sustain the conversation rarely end with the teacher indicating correct or incorrect responses. Classroom discourse is characterized by the consistent use of feedback/probes that encourage deeper/more meaningful exploration of ideas.
Individualized descriptive feedback Providing learners with evidenced-based feedback that is linked to the intended set outcomes and criteria of success	The teacher provides no descriptive feedback, only provides a score or percentage mark. There is no opportunity for learners to internalize the feedback (review the feedback and/or ask questions) The teacher provides descriptive feedback (written or verbal), but no opportunity for learners to use the	The teacher provides descriptive feedback (written or verbal) without a score of percentage mark that supports the learning goals and/or criteria for success. There is no opportunity for learners to internalize the feedback (review the feedback and/or ask questions) There is no opportunity for the learners to use the feedback in a meaningful way (apply it to the current or next task).	The teacher provides descriptive feedback (written or verbal) without a score of percentage mark that supports the learning goals and/or criteria for success. Learners are provided with opportunities to internalize the feedback (review the feedback and/or ask questions). Learners are provided with opportunity for the learners to use the feedback in a meaningful way (apply it to the current or next task).

	feedback in a meaningful way (apply it to the current or next task).		
Peer assessment It provides learners an opportunity to think meta-cognitively about their learning.	Learners are not provided with any opportunities to engage in the assessment of their peers' work. The learners are asked to mark their peers' work (e.g. test, class work/homework) for a summative purpose.	The peer assessment task does not appear to be meaningful to most leaners (learners do not take the task seriously or perceive value in the task). The peer assessment does not have an impact on the quality of learner work due to the quality of feedback or lack of structure for using the feedback (time to read and revise).	The teacher asks learners to assess their peers' work and provide feedback to improve the quality of the work. The peer assessment task is structured in a way (e.g. the task is modelled for learners, exemplars of feedback are provided) that supports all learners to complete the peer assessment and provide feedback that support learning.
Self-assessment It provides learners wit opportunity to think meta-cognitively about their learning.	Learners are not provided with any opportunities to engage in self-assessment of their work. Learners are asked to mark their work for summative grade.	The teacher asks learners to mark their own learning, but the self-assessment lacks structure and does not support learners. The task has not been modeled for learners, learners, they have not been provided with examples. Most learners struggle to complete an honest self-assessment.	The teacher asks learners to assess their own work. The self-assessment task is structured in a way (e.g. modeled for learners, exemplars are provide) that supports all learners to complete an honest self-assessment.
Collaboration Establishing a classroom culture which teacher and learners are partners in learning.	The classroom climate is characterized by an overall perception that the teacher is "in charge". Learner participation is limited to when the teacher asks a question, and the teacher does not	The classroom climate is characterized for the most part by an overall perception that the teacher is "in charge". Learner participation is limited to when the teacher asks a question, and the teacher rarely capitalize on learner responses or learner	The classroom climate is characterized by an overall, consistent perception that the teacher and the learners are supporters of learning. Learner participation is spontaneous (while respectful), and the teacher often capitalizes on learner responses or

	capitalize on learner responses or learner questions to deepen learning.	questions to deepen learning.	learner questions to deepen learning. For most part, the teacher promotes an attitude of "we can all learn".
Use of evidence to inform teaching and learning Formative assessment is a process used by teachers and learners to during teaching that provides feedback to adjust ongoing teaching and learning to improve learners' achievement of intended outcomes.	There is little or no attempt by the teacher to collect evidence of student learning in the lesson that is connected to the learning goals or criteria for success. The collection of evidence is so minimal or inconsistent that there is no way for the teacher to gain insight into student learning.	There is some evidence that the teacher collects evidence of learning that is weakly connected to the learning goals or criteria for success. The teacher does not analyze the evidence to identify patterns of understanding/misunderstanding or make inferences about learner strengths and weaknesses. The information is not used to shape pedagogical decisions.	The teacher uses several ways that are connected to the learning goals or criteria for success to collect evidence of learning. There are multiple sources of evidence that indicate the teacher is analyzing the evidence to identify pattern of understanding/misunderstanding or making inferences about learner strength and weaknesses. Information, identified patterns, and inferences are used to shape pedagogical decisions.