

**An investigation into Science teachers' conceptions of and dispositions
towards the implementation of 'assessment for learning' (formative
assessment) during science practical activities**

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By

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DECLARATION

I, Felisia Sheehama declare that the study: *An investigation into science teachers' conceptions of and dispositions towards the implementation of 'assessment for learning' (formative assessment) during science practical lessons* is a presentation of my original work. Where contributions of others are involved, every effort has been made to reference and acknowledge their work.

Signature: 

Date: 10 April 2017

ABSTRACT

Assessment is an integral part of the teaching and learning process. Research by the Assessment Reform Group (ARG) (1999) and others has shown that assessment for learning, or formative assessment, is one of the most powerful educational tools for promoting effective learning and improving performance. Assessment for learning (formative assessment) and summative assessment form part of most national education policies and is advocated in the Namibian curricula. However, most of the focus of official programs in Namibia has been on summative assessment resulting in assessment for learning being neglected. It is against this backdrop that this study investigated science teachers' conceptions of, and dispositions towards, the implementation of assessment for learning during science practical lessons.

In this study, a mixed methods case study approach underpinned by an interpretive paradigm was adopted. The research was conducted with 25 in-service science teachers from schools in Namibia who were all on a two year part-time BEd (Honours) program delivered at NIED in Namibia by a South African university from the Eastern Cape. To generate data, document analysis, questionnaires, semi-structured interviews, an intervention in the form of workshops on assessment for learning, practical activities, lesson observations (which were videotaped), as well as teacher reflections were used. The lesson observations were conducted in two schools in the Omusati region of Namibia. The theoretical frameworks guiding the study were Vygotsky's social constructivist theory and Shulman's pedagogical content knowledge (PCK).

The findings of the study revealed that teachers held different notions toward assessment for learning before the intervention in the form of a workshop. However, after the workshop the teachers demonstrated understanding of what assessment for learning entails and how it can be implemented during hands-on practical activities using easily accessible resources. A recommendation is that if teachers are given opportunities, through professional development platforms, to engage in hands-on practical activities using easily accessible resources and an appropriate orientation towards assessment for learning that includes model strategies they can be enabled and motivated to research and begin to implement assessment for learning in their science classrooms.

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LIST OF ABBREVIATIONS AND/OR ACRONYMS

ACE	Advanced Certificate in Education
AfL	Assessment for Learning
ARG	Assessment Reform Group
ASEP	Australian Science Education Project
B.Ed. (Hons)	Bachelor of Education degree Honours
BETD	Basic Education Teacher Diploma
CASS	Continuous Assessment marks
CD	Compact Disc
CPD	Continuous Professional Development
Dip. Ed.	Diploma in Education
EFA	Education for All
EHDC	Education Higher Degree Committee
HOD	Head of Department
LCE	Learner Centred Education
MOE	Ministry of Education
MASTEP	Mathematics and Science Teacher Extensions Programme
NCBE	National Curriculum for Basic Education
NDP	National Development Plan
NIED	National Institute for Educational Development
PCK	Pedagogical Content Knowledge
PDP	Professional Development Programme
PEEOE	Predict Explain Explore Observe Explain
TOT	Training of Trainers
TR1-TR23	Teacher Reflection number 1 up to 23
T ₁ Q ₁ F	Teacher Questionnaire number 1-21 (F, Female & M-Male)
SAARMSTE	Southern African Association for Research in Mathematics, Science and Technology Education
SACMEQ	Southern and Eastern Africa Consortium for Monitoring Educational Quality
SEO	Senior Education Officer
ZPD	Zone of Proximal Development

CHAPTER 1: SITUATING THE STUDY

1.1 Introduction

The purpose of this research study was to investigate science teachers' conceptions of and dispositions towards the implementation of Assessment for Learning (Formative Assessment) during science practical activities. In this chapter, the background of the study is provided. In addition, this chapter highlights Assessment for Learning from the international perspective in order to get a picture of what the international community has thus far embarked on and culminates by emphasising the Namibian context. It further presents the statement of problem, research goal and research questions. The research site is explained. The potential value of the study is also discussed. Lastly, key concepts in the study are defined and the thesis outline is provided. The chapter ends with some concluding remarks.

1.2 Background to the study

This section presents the context of the study from international and regional contexts.

1.2.1 International and regional background of the study

Practical activities play an important role in the teaching and learning of science. Several studies have recognized the importance of practical activities (Abrahams, 2009; Hodson, 1990; Millar & Millar, 2010; Woodley, 2009). For instance, Hodson (1990) identified that the role of practical work is to motivate learners and to teach laboratory skills. Practical activities enhance the learning of scientific knowledge, develop expertise and develop certain scientific attitudes.

Notwithstanding, there have been questions about the effectiveness of practical work as a teaching and learning strategy (Abrahams & Milar, 2008). Hodson (1990), for example, believes that the way teachers are conducting practical activities leaves a lot to be desired. Hence, he describes the practical work done in schools as often being ill-conceived, confused and unproductive and providing little of real educational value. Furthermore, he posits that some teachers use practical work unthinkingly because they have been subjected to the powerful rhetoric of the profession that sees hands-on practical work as the universal panacea; the educational solution to all learning problems. Hodson's (1990) views resonate well with Gott and Dungan (1996) who argue that practical work for its own sake is no longer sufficient justification. Furthermore, Kibirige, Osondo and Mgiba (2014) indicate that science teachers

had misconceptions regarding the purpose of practical work. In view of the above arguments, Maselwa and Ngcoza (2003) put it in more radical terms by stating that there is often a tendency for science teachers to equate practical activity with learning. On the other hand, one of the main challenges identified is that teachers lack the confidence to conduct practical activities, since during teacher training many universities did not have a practical activity component in their curriculum (Heeralal, 2014).

Countries such as Australia have reviewed how teachers conduct practical work. The Australian government developed their own project called Australian Science Education Project (ASEP) in order to review their practical work practices. A study by Kidman (2012) revealed that practical work in Australian schools is multifaceted, and the teacher-aligned purposes are dependent not only upon the age of the student, but also on the type of practical work being undertaken. Their study showed that most teachers are not ready to teach using inquiry-based pedagogy and cite lack of content knowledge.

A study conducted in Namibia by Kapenda, Kandjeo-Marenga, Kasanda and Lubben (2002) revealed that the way practical task information was provided to learners was not always clear either from the lesson plan or the student work. These scholars further found that in a few cases, instructions were issued orally, or that the learners were referred to a textbook. From a similar line of thinking, Kandjeo-Marenga, Kapenda, Lubben, Campbell, !Gaoseb and Kasanda (2006) also provide some insight that Namibia introduced a professional development programme, called MASTEP, which set out to improve the teaching of Mathematics and Science in Namibia and to enhance teachers' understanding of science content and improving their pedagogical knowledge and skills. However, despite the initiatives of MASTEP, it was evident that half of the practical activities conducted were mere demonstrations. According to these authors there seems to be very little learning taking place during practical work or practical activities in the Namibian classes they observed, and that there is a need to look at innovative ways to enhance learning during practical activities.

Many researchers emphasize the importance of assessment for learning in promoting learning and enhancing performance. Black and William (2002) have produced evidence showing a significant positive impact on student performance where formative assessment or assessment for learning is done well. Moiiinvaziri (2015) notes that the formative assessing of students has many purposes, such as providing information on learning progress, diagnosing specific

strengths and weaknesses in an individual's learning with a view to enhance further learning and in encouraging learners to take greater responsibility for their learning. The influential study, *Inside the Black Box* by Black and William (2002) has presented a series of best practices and strategies such as effective questioning, clear learning goals, giving immediate feedback as well as peer and self-assessment. This is based on extensive research into understanding that learning can be assisted by formative assessment and the recommendation that teachers should experiment with Assessment for Learning if they are seeking to improve their own assessment for learning classroom practice. Black and William (2002) have produced evidence showing a significant positive impact on student performance where formative assessment or assessment for learning is done well. As alluded to by the Assessment Reform Group (ARG, 1999), Assessment for Learning is appropriate in all situations and helps to identify the next steps to build on success and strengths as well as to correct weaknesses. However, they found that in many classrooms in the UK assessments for learning or formative assessment was not fulfilling its full potential, yet these same teachers would materially enhance their classroom practices in this area when given models of good practice and they specifically focused on improving their practice in this area.

Given the centrality of practical work in science education and the evidence for assessment for learning being able to enhance student learning and performance, this raises the question of whether or not formative assessment is being used within the practical work classrooms and if it is fulfilling its full potential for enhancing the learning in these lessons.

Thus, it was the intention of this study to engage with a sample of Namibian science teachers to implement Assessment for Learning strategies during practical activities and to investigate the potential for enhancing its role in practical work science lessons.

1.2.2 The Namibian National Curriculum for Basic Education

The goal of the Namibian National curriculum for Basic Education contends that the purpose and content of the curriculum framework is to guide the teaching and learning process. Essentially, the curriculum further stresses the need to ensure that assessment is closely integrated in the teaching and learning process where teachers' use of assessment for planning purposes (Namibia. Ministry of Education [MOE], 2010). In order to ensure that assessment is fully integrated, it can only be achieved if teachers are fully equipped and aware of what is expected of them.

Another very important point frequently underlined in the curriculum is that it should be learning-driven. This implies that assessment and examinations are there to support learning (Namibia. MoE, 2010). The curriculum further highlights that assessment has a formative role for learners when guided by the following:

- It is used to motivate learners to extend their knowledge; and
- The task given should help learners to solve problems intelligently by using what they have learned and the teacher uses the information to improve teaching methods and learning materials (Namibia, MOE, 2010, p. 31).

However, despite the foregrounding for formative assessment in the curriculum, there is evidence from a few studies done on the problem in Namibia (Iileka, 2010; Kaoseb, 2015) that teachers here, as had been the case in the UK and Australia, still tend to focus on summative assessment and that formative assessment is not fulfilling its full potential to enhance learning and student performance. They argue that the CASS system gives the appearance of having implemented effective formative assessment in the Namibian schooling system, but that it is largely orientated towards generating marks for the year mark and little attention is given to using it in a formative way to enhance learning.

1.3 Statement of the problem

The policy documents such as the Namibian National Curriculum for Basic Education (2010) advocate the use of practical work or practical activities in the science classes. The evidence indicates that many teachers struggle with how to best conduct practical work or practical activities in science lessons, even leading to some instances where practical activities are not done at all (Nghipandulwa, 2011). The National Curriculum also emphasizes the use of both formative and summative assessment in all subjects including science, but the evidence is that formative assessment is not getting the priority it needs in many classrooms and is not fulfilling its potential for student learning and performance.

For instance, if clear learning goals are not considered during practical work there is a distinct risk that they will not be achieved. Further, if the learning goal is not shared with the learners they will not be co-partners trying to achieve the required learning. The all-important role of timely and appropriate feedback to students is so central to effective learning and the question arises of the nature of the feedback given in practical science lessons. There is also the question of how strategic and effective are the questions being posed by teachers and students in these practical science lessons?

The above all suggests that there is need to gain a better understanding of how science teachers make use of Assessment for Learning or formative assessment during practical activities in particular. Hence, the study seeking to investigate science teachers' conceptions of, and dispositions towards, the implementation of assessment for learning (formative assessment) during science practical lessons became imperative.

My interest to engage in this study was triggered in part by the fact that in most Namibian schools the emphasis is on summative assessment and little attention is given to formative assessment. During the past seven years of my teaching career, for instance, I have also been finding it difficult to engage learners in deeper learning. Asking quality questions and giving constructive feedback to learners has been challenging. I also realized that when I conducted practical activities learners still found it difficult to answer questions. There seems to be a gap in effectively conducting practical activities. However, during my postgraduate training as a BEd Honours student in 2014, I was exposed to the concept of Assessment for Learning. This motivated me to try and make use of assessment for learning during practical lessons in order to improve teaching and learning. This study is thus an attempt to realize the importance of taking into consideration AfL/formative assessment during practical lessons.

1.4 Significance of the study

The following are thus potential values of this study:

- In Namibia, little research has been done on Assessment for Learning as well as on how to improve the implementation of practical activities. Therefore, this research will provide a baseline data for gaining a better insight into these related areas.
- The study might also inform curriculum developers and planners on the challenges that teachers face as they implement assessment for learning strategies.
- Likewise, as a Life Science teacher, the study might improve my own teaching practice.

1.5 Research goal, objectives and questions

This section presents the research goal, research objectives, main research question and the sub-questions.

1.5.1 Research goal

The main goal of this study was to investigate science teachers' conceptions of and dispositions towards the implementation of assessment for learning (formative assessment) during science practical activities.

1.5.2 Research Objectives

The objectives of this study are to:

- Find out science teachers' conceptions of assessment for learning;
- Find out how science teachers' make use of assessment for learning;
- To explore how an intervention in the form of a workshop on assessment for learning during science practical activities influences teachers' dispositions; and
- To identify factors that enable/constrain the implementation of assessment for learning during science practical activities.

To realise this main goal and objectives of this study, the study was guided by the following questions:

1.5.3 Main research questions

What are science teachers' conceptions of, and dispositions towards, the implementation of assessment for learning (formative assessment) during science practical lessons?

The following sub-questions were answered:

Phase I: Baseline study

1. (a) What are science teachers' views and experiences of the implementation of assessment for learning (AfL) during science practical lessons?

(b) What factors influence the science teachers' views and experiences on the use of assessment for learning (formative assessment) during science practical activities?

Phase II: Intervention orientation workshop on Assessment for learning strategies

2. How does the intervention in the form of workshop on assessment for learning (AfL) influence science teachers' conceptions and dispositions towards the use of assessment for learning (AfL)?

Phase III: Implementation of assessment for learning strategies in the classroom

3. How do science teachers make use of assessment for learning (AfL) during their practical activities?
4. What factors enable and/or constrain science teachers' conceptions and dispositions towards the implementation of assessment for learning (AfL) during their science practical lessons?

1.6 Conceptual framework

The study was guided by the following concepts, namely, teachers' conceptions and teachers' disposition. In this study, conceptions refer to teachers' beliefs and experiences towards both formative and summative assessment. It is believed that teachers' conceptions affect the way they teach. Dispositions, in this study refers to the beliefs and attitudes towards science knowledge and teaching strategies and any change in such. Atallah, Bryant and Dada (2010) define dispositions as the beliefs or tendencies to exhibit a frequent, conscious and voluntary behaviour directed towards learning a subject. The concepts of teachers' conceptions and teachers' disposition are discussed in detail in Chapter 2 of the study. The next section presents the theoretical framework guiding the study.

1.7 Theoretical Framework

Imenda (2014) states that a theoretical framework refers to the theory that a researcher chooses to guide him/her in his/her research by using a set of concepts from the theory to offer an explanation of an event. The study was guided by two theoretical frameworks, namely, Vygotsky's (1978) social constructivism and Shulman's (1986) Pedagogical Content Knowledge (PCK). According to Vygotsky (1978), learning happens through social interactions with parents, teachers, other learners and knowledgeable adults. In addition, Shulman (1986) understands PCK as representing the blending of content and pedagogy.

1.8 Data gathering techniques

The following data techniques were used to gather data:

- Questionnaires;
- Observations;
- Reflections; and
- Semi- structured interviews.

1.9 Definition of key concepts

The key concepts that are used in this thesis are defined below.

1.9.1 Assessment for Learning¹ One of the leading research teams on the topic best described Assessment for Learning as follows:

Assessment for learning is any assessment for which the first priority in its design and practice is to serve the purpose of promoting students' learning. It thus differs from assessment designed primarily to serve the purposes of accountability, or of ranking, or of certifying competence. An assessment activity can help learning if it provides information that teachers and their students can use as feedback in assessing themselves and one another and in modifying the teaching and learning activities in which they are engaged. Such assessment becomes "formative assessment" when the evidence is actually used to adapt the teaching work to meet learning needs, (Black, Harrison, Lee, Marshall & Wiliam, 2004, p. 10).

1.9.2 Formative Assessment - An assessment is formative to the extent that information from the assessment is used, during the instructional segment in which the assessment occurred, to adjust instruction with the intent of better meeting the needs of the students assessed (Popham, 2006, pp. 3-4).

1.9.3 Conceptions - According to Brown and Gao (2015), conceptions refer to the ideas, values and attitudes people have toward what something is (i.e. what they think it is and how it is structured) and what it is for (i.e. its purpose). Conceptions of assessment, then, refer to a teacher's understanding of the nature and purpose of how students' learning is examined, tested, evaluated or assessed.

1.9.4 Dispositions - Atallah, Bryant and Dada (2010) define dispositions as the beliefs or tendencies to exhibit a frequent, conscious and voluntary behaviour directed towards learning a subject.

1.9.5 Pedagogic content knowledge - Shulman (1987) states that PCK represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction.

1.9.6 Practical activities/work - Millar (2004) defines 'practical work' as any teaching and learning activity which involves at some point learners observing or manipulating real objects and materials.

¹ The terms Assessment for Learning and formative assessment are used interchangeably in this study.

The next section provides an overview of the chapters of the thesis.

1.10 Structure of the thesis

Chapter 1 - Situating the study: This chapter provides the overview of the research by highlighting the background of the research, problem statement, rationale of the study including potential value of the study and defining the key concepts used in the study and it presents an outline of the thesis chapters.

Chapter 2 - Literature review: This chapter presents literature informing the study, namely, formative assessment, assessment for learning and the role of practical activities. Secondly, it presents the conceptual framework informing the study, viz., teachers' conceptions, professional development and dispositions. Lastly, this chapter discusses the theoretical frameworks that informed this study.

Chapter 3 - Research design and methodology: This chapter presents the research design, methodology and the data gathering techniques used to collect the data in this study. The study used questionnaires, document analysis, observations, reflections and semi-structured interviews for data collection. In addition, a brief discussion of how data were analysed and validated is provided. Lastly, issues of validity, trustworthiness and ethical consideration are presented.

Chapter 4 - Data presentation (Phase I - Baseline data): This chapter presents data from phase I which is a baseline study. The data are presented into two parts; quantitative and qualitative data. Quantitative data includes teachers' demographic information as well as other quantitative data on assessment for learning. On the other hand, qualitative data focused on teacher's conceptions, views and experiences toward the use of assessment for learning (formative assessment) during the teaching of science. Lastly, teachers' conceptions and experiences are analysed and discussed in relation to the relevant literature/ theory.

Chapter 5 - Data presentation (Phase II - Intervention orientation workshop): This chapter presents data from phase two of the study. This phase consisted of an intervention in the form of workshop on Assessment for Learning as well as practical activities using easily accessible materials. It also presents data from participants' reflections. This chapter sheds light on teachers' conceptions toward assessment and their disposition after having been exposed to a series of practical activities during an intervention workshop.

Chapter 6 - Data presentation (Phase III - Classroom observation): This chapter presents data from phase three of the study. This phase includes data from observations when two teachers implemented assessment for learning strategies during practical activities. It also includes data from the post reflective interviews after the conducting of practical activities.

Chapter 7 - Summary of findings and Recommendations: This chapter summarises the findings of the study. The chapter is presented as follows:

- Firstly, the data presented in chapter 4, 5 and 6 are summarised in relation to the research questions.
- Recommendations and avenue for future research.
- Research journey “Reflections” and Conclusion.

1.11 Concluding remarks

This chapter started by introducing the chapter, followed by the background of the study, statement of the problem, significance of the study. The chapter further presented the research goal, research objectives, research question and the sub-questions. The conceptual and theoretical frameworks, research methodology are highlighted. In addition, key concepts used in the study are defined. The chapter concludes by highlighting the structure of the thesis.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The purpose of this study was to investigate science teachers' conceptions of, and dispositions towards, the implementation of assessment for learning (formative assessment) during science practical activities. It thus sought to understand how teachers' conceptions affect the way they implement assessment for learning strategies as well as understanding teachers' dispositions towards assessment after being exposed to a workshop. To achieve the purpose of the study, I present relevant literature in relation to practical activities and assessment for learning. The literature is presented in sections as follows:

- Assessment for learning (formative assessment) as reflected in the Namibian curriculum
- Conceptual frameworks; teachers conceptions, teachers professional development, teachers' dispositions and
- The theoretical framework, namely social constructivism and Pedagogical Content Knowledge which inform the study.

2.2 The National Curriculum for Basic Education (NCBE)

The Namibian curriculum provides a framework for the teaching and learning processes expected in the various subjects.

2.2.1 The Namibian curriculum expectations

The National Curriculum for Basic Education (NCBE) of 2010 is a guiding document for Namibian teachers during planning, organising, implementing teaching and learning (MOE, 2010). The policy document is intended to ensure that there is consistency in the delivery of the curriculum in schools. In relation to this study, the curriculum sets in place assessment procedures and prescribes that assessment is clearly integrated in the teaching/learning processes. To meet its goal and aims, the curriculum has specific principles that teachers need to adhere to and use during their teaching. One of the key principles emphasised by the curriculum is *teaching, learning and assessment*. The curriculum sees these three aspects as intertwined rather than separate.

2.2.2 Learner centred education in the Namibian curriculum

The broader goal and aim of Vision 2030 is to make Namibia a knowledge-based society. To meet the goal of Vision 2030, teachers need to provide quality education. Since independence, Namibia has embarked on various strategies to ensure that goal 4 “*access to quality education*” of NDP is realized. It states that access to quality education entails engaging teachers in professional development programmes in order to sharpen their subject content knowledge and the pedagogical skills. This means that teachers need to be equipped with the necessary skills such as understanding of learner centred education (LCE), new teaching approaches and assessment for learning in order to provide meaningful quality education.

The philosophy of LCE in Namibia provides a framework to improve the quality of teaching and learning. This involves a child exploring his/her social and material environment, communicating with others, playing, experimenting things and reflecting (NIED, 2003). The concept of LCE is shaped by and reflected in the Vygotsky theory of social constructivism. Thus social interaction is one of the core tenets of LCE. In the context of this study, the philosophy of learner centred education is about learners engaging with other learners and the teachers; learners to reflect on what they did well and where they need to improve and teachers using pedagogy such as principle of assessment for learning so that learners are actively involved in the lesson. It argues that if teachers fully understand the concept of LCE they will be able to provide meaningful quality education.

In its guide to LCE the Namibian National Institute for Educational Development (NIED, 2003), a conceptual framework document, defined what is meant by quality education:

Quality means the relevance, meaningfulness, and reasonableness of challenge in education are in the foreground. The curriculum, the teachers, material and the learning environment should all be of high standard. Those standard need to be defined so that the quality of education is monitored and improved where necessary (NIED, p. 5).

The Namibian guiding documents such as *Towards Education for All* (EFA) encourages teachers to provide quality education. However, in the recent SACMEQ report by Miranda, Amadhila, Dengeinge and Shikongo (2011) express concern about the quality of education in Namibia.

Some studies have shown that Namibian teachers grapple to provide quality education as revealed in the SACMEQ report (Makuwa, 2005). Concurring to the above findings, the UNICEF report by Ninnes (2011) revealed that Namibian teachers have problems in properly

sequencing ideas. It was observed that teachers were presenting ideas in illogical sequences that simply confused the learners. The report observed that teachers need to be able to present ideas to learners in a logical way whereby learners are led step-by-step from concepts they understand to the understanding of new concepts.

Additionally, the UNICEF report revealed that the Namibian classroom is characterised by poor questioning techniques that failed to encourage higher level thinking and did not systematically engage all learners in the class. In support of this Nyambe (2008) found that teachers' lack of professional confidence, lack of support from NIED, and lack of academic preparedness is hindering the proper implementation of LCE and making it difficult to provide quality education. Furthermore, Chisholm and Leyendecker (2007) highlighted that the main obstacle of the Namibian Life Science teachers is that they seem to have unclear understanding of the actual application of learner-centred education and its scope of the intended change.

2.2.3 Assessment within the Namibian National Curriculum for Basic Education

Assessment follows a learner centred curriculum which uses a broad range of knowledge and skills relevant for a knowledge-based society. It is a mechanism used for evaluating learners' learning progress. The curriculum for basic education states the types of assessment which should be used for assessing learners' learning progress in each subject.

- **Formative assessment:** assessment used during the lessons to help shape and direct teaching and learning progress. For example, questions asked during lessons and feedback given during the lesson;
- **Summative assessment:** the assessment done to sum up the progress and achievement of learners throughout the year. For example, class test, end of year test or examination;
- **Continuous assessment:** records of marks given for activities that learners do as class work, assignment, homework or tests (MoE, 2010).

The emphasis, as stated in the NCBE, is to make use of assessment to support learning. However, the curriculum and subject policy is not explicit on how teachers should use assessment to support learning and how the curriculum should be learning driven.

Kaoseb (2015), in her review of the Namibian CASS system, concluded that "In addition the study found that the CASS system which was implemented to bring the CA policy into realisation has in fact become a system geared toward gathering summative continuous

assessment grades, thus not realising the intended goals of developing and implementing formative continuous assessment practices in classrooms.”

In the next section I present expectations of the Life Science syllabus.

2.2.4 Namibian Life Science syllabus expectations

The Namibian Grade 8-10 Life Science syllabus (Ministry of Education, MOE, 2010, pp. 2-5) expects science teachers to do the following;

- Teachers are expected to have a holistic view of the learner, valuing the learner’s life experience as the focal point of learning and teaching;
- Teachers should therefore select learning content and methods on the basis of the learners’ needs within their immediate environment and community;
- Teachers should develop a lively, questioning, appreciative and creative intellect to enable learners to discuss issues rationally, to make careful observations and analysis, to think scientifically, to solve problems and apply these skills to tasks;
- The teacher must be able to explore the needs of learners, the nature of learning to be done, and how to shape learning experiences accordingly;
- Teaching strategies must therefore be varied yet flexible within well-structured sequences of lessons;
- The teacher must decide, in relation to the learning objectives and competencies to be achieved, when it is best to convey content directly and when it is best to let learners discover or explore information themselves; and
- The teacher should also decide when learners need directed learning, and when they need reinforcement or enrichment learning. She/he must furthermore decide when there is a particular progression of skills or information that needs to be followed or when learners can be allowed to find their own way through a topic or area of content.

The Life Science expectations imply that teachers need to make use of learner centred approaches in order to meet the needs of learners. Teachers are encouraged to ensure that learners should be actively involved in the learning process. In the next section I present the assessment objectives.

The syllabus states three assessment objectives, knowledge with understanding, handling information and solving problem as well as practical (experimental and investigative) skills. After completing the Life Science syllabus, learners are expected to demonstrate the following assessment objectives.

Table 1: Extracts from Life Science syllabus (Assessment objectives)

Assessment objectives	Details
A. Knowledge with Understanding	<p>Learners should be able to demonstrate knowledge and understanding in relation to:</p> <ul style="list-style-type: none"> • scientific language, terminology, symbols, quantities and units; • instruments and apparatus, including techniques of operation and aspects of safety; • the use of scientific facts, concepts, patterns and principles. <p>The objective is made up of Basic Competencies which require the learner to identify, give examples, name, list, state, indicate, give reasons, suggest ways, recognise, define, discuss and to outline.</p>
B Handling Information, Application and Solving Problems	<p>Using written, symbolic, graphical and numerical material, learners should be able to:</p> <ul style="list-style-type: none"> • analyse novel situations in a logical and deductive manner; • locate, select, organise and present information from a variety of sources; • translate information from one form to another; • use information to identify patterns, report trends and draw inferences; • present reasoned explanations for phenomena, patterns and relationships; • make a value judgement about scientific and technological applications and their social, economic and environmental implications; • solve problems. <p>This objective is made up of Basic Competencies which require the learner to predict, relate, describe, calculate, find, estimate, determine, sketch, and select, analyse, extract and analyse, synthesize, compare and discuss, deduce, explain, distinguish, suggest, interpret, and evaluate.</p>
C Practical (Experimental and Investigative) Skills	<p>Learners should be able to:</p> <ul style="list-style-type: none"> • use and organise techniques, apparatus and materials; • observe, measure and record; • handle, process and evaluate experimental observations and data; • plan investigations.

(Namibia, MOE, 2010, p.36)

My study focused how best we can achieve domain C (practical activities).

2.3 Assessment for learning (Formative assessment)

Assessment, both summative and formative, is one of the strategies teachers can use during practical activities. In this section assessment for learning strategies are described.

2.3.1 Assessment for Learning

Black, Harrison, Lee, Marshall and William (2004, p.10) define assessment for learning as “any assessment for which the first priority in its design and practice is to serve the purpose of promoting students’ learning”. A group of ARG (2002) view assessment for learning as a process of seeking and interpreting evidence for use by learners and their teachers to decide where learners are learning or not, where they need to go and how best to get there. This is the type of assessment where the focus is on learning rather than grading. This assessment is about using information gathered from learners to improve learning by modifying the teaching strategies to meet learners’ needs. According to Black and William (2002), the term ‘assessment’ refers to all those activities undertaken by teachers. It is also about learners assessing themselves, which may provide information to be used as feedback to modify the teaching and learning activities in which they are engaged.

For the purpose of this study, my focus was on practical activities undertaken by teachers to enhance learning. This study views Assessment for Learning as a strategy that can be used to enhance learning and improve active engagement during science practical activities.

Assessment for learning plays an important role in the teaching and learning process. Black and William’s (2002) study revealed a significant positive impact on students’ performance when assessment for learning is done well. Concurring, Willis (2009) points out that assessment for learning informs both teachers and students about the learning process and progress thereof. Researchers such as Hodgson (2010), Linqanti (2014), and Thomas (2012) speaking of results of studies done outside Namibia concur that assessment for learning can improve the quality of teaching and improve student learning.

Bell and Cowie (2001) accentuate that the role of formative assessment can be viewed as the process by which teachers gather assessment information about the students’ learning with a

view to promote further learning. Lending support, Jones (2005) points out that assessment for learning is all about informing learners of their progress to empower them to take the necessary action to improve their performance. Concurring, Rashid and Jaidin (2014) posit that AfL provides an avenue for teachers to give feedback on the students' performance during each lesson.

Leahy, Lyon, Thompson and William (2005) explain that assessment for learning involves teachers adjusting their teaching methods. They came up with a set of five broad strategies based on extensive research that are now the starting point of many assessment for learning teacher development initiatives in the UK, Australia, Canada and the USA namely:

- Clarifying and sharing learning intentions and criteria for success;
- Engineering effective classroom discussions, questions and learning task;
- Providing feedback that moves students forward;
- Activating students as the answers of their own learning; and
- Activating students as instructional resources for one another.

Furthermore, Jones (2005) points out that assessment for learning is all about informing learners of their progress to empower them to take the necessary action to improve their performance. To this end William (2011) is of the opinion that under certain conditions assessment has considerable potential to enhance learning. Subsequently, this may be attributed to a number of factors including, differences in teachers understanding and experiences about assessment for learning. For instance, a recent study conducted in Asia by Rashid and Jaidin (2014) pointed out some teachers experience AfL such as: 1) students playing an active role in learning; 2) making lesson objectives explicit and transparent to students; 3) a tool to continuously assess the students' understanding during lessons; and 4) a directive from the authority. In addition, ARG (1999) offers a broad perspective of assessment for learning as assessment that deals with sharing learning goals, asking quality questions, giving immediate feedback, peer and self-assessment.

Tofade, Elsner and Haines (2013) advocate that questioning is among the most powerful teaching tools and adopting best practices that can significantly enhance the quality of instruction. Questioning can be used for a variety of purposes. Sullivan (2003) points out that questioning is the key means by which teachers find out what learners already know, identify

gaps in knowledge and understanding and scaffold the development of their understanding to enable them to close the gap between what they currently know and the learning goals.

In a study carried out in Tanzania, Paulo (2014) found that even though most science teachers in Tanzania ask questions during the teaching and learning process, findings reveal that they allow a very short waiting time. These findings resonate with those of Uugwanga (2015a), who suggested that teachers should give learners time to think (wait time) about the possible answers to the questions posed without interrupting them. Paulo (2014) added that when teachers realize that no student volunteers to answer, they either seek answers from bright students, answer the questions themselves or switch to closed ended simple questions where recall of memorized information rather than critical thinking provide answers. This implies that teachers should give enough time to learners to think about the answer without any interruption.

Jones (2005) points out that questioning is something every teacher does naturally as part of the daily routine. However, developing the skills associated with questioning techniques presents many challenges for teachers and is something that is developed over time. Black (2002) is of the opinion that in order to bring change in classroom practice, teachers need to move away from the routine of asking limited factual questions and refocus attention on the quality and the different functions of classroom questions. However, a study conducted in Turkey suggests that “In order to ask questions that develop thinking skills, teachers should receive in-service training and attend workshops about questioning techniques” (Kucuktepe, 2010, p. 5195). The art of asking questions requires learners’ responses and teachers giving feedback.

Rashid and Jaidin (2014) highlighted that giving feedback is a central element of Assessment for Learning as it helps to show the students where they are on their path to attaining the intended learning outcome. Hodgson (2010) emphasises that constructive feedback should be given during the discussions and practical tasks. Gioka (2007) emphasised that giving feedback involves making time for students to talk, and to teach them to be reflective about the quality of their responses. Furthermore, drawing on Gioka’s (2007) study, the quality of dialogue and discussion in feedback sessions is important. Teachers need to talk to learners about their weaknesses. Paulo (2014) alerts us on the importance of giving feedback so that students are able to build on their strengths and work on their weaknesses.

One more useful suggestion that Leahy, Lyon, Thomson and William (2005) make is that for feedback to be effective, it needs to cause thinking whereas giving grades does not do that. Chappuis and Stigging (2002) put it in more radical terms by saying effective teacher feedback describes why an answer is right or wrong in specific terms that students understand. Descriptive feedback should provide ways for students to improve in clear, constructive language. This can be achieved through communicating clear goals for assessment as proposed by (Gioka, 2007).

According to ARG (1999), it reveals that feedback given to learners often serves social and managerial purposes rather than helping them to learn more effectively; as a result this leads to teachers not knowing enough about their learners' learning needs. As mentioned above, teachers need to effectively use feedback to enhance learners' conceptual understanding. To this end, Paulo (2014) is of the opinion that teachers can raise learners' achievement by providing feedback which enlightens them to identify their subsequent learning steps how to take them and build on success and strength as well as correct weakness. In order to help students learn and benefit from such assessment tasks, the teacher should give descriptive feedback which may point out a student's weaknesses and strengths on experimental procedures (Paulo, 2014).

Various authors such as Gioka (2007); Linquanti (2014); and Paulo (2014) have emphasised that teachers need to be clear of the intended learning goals so that learners can understand the goals they are pursuing and what they are aiming to achieve. William (2013) expresses similar sentiments that teachers should share learning goals with their students so that learners will be aware of the intended goals. In a study by Gioka (2007) it was observed that most teachers presented the learning goals and objectives in the form of key scientific terms at the beginning of a new model or a lesson unit, and summarized them at the end of the lesson, in the plenary session. Furthermore, assessment criteria and learning goals need to be expressed in a language that students understand so that they can understand the goals they are pursuing and the quality of work they are aiming for. Apart from asking quality questions, giving feedback and clear learning goals, teachers are faced with challenges that affect effective implementation of AfL.

Researchers such as Paulo (2014, p.144) have pointed out some of the challenges:

- Teachers view assessment for learning practices as different from summative form of assessments. This perception results into low adoption of assessment for learning because summative assessment is prioritized in the national assessment systems;
- Lack of positive personal experience of assessment for learning among teachers is also a barrier; and
- Assessments may be practically constrained by shortage of time and large class size.

Kuze and Shumba (2011), in their study conducted in South Africa, highlighted some factors inhibiting formative assessment such as the teacher's lack of knowledge, lack of training and resources, and the willingness of learners to study their books. They further concluded that non-implementation of policy is attributed to lack of knowledge, and a lack of training. The assumption is that these teachers must have found difficulty in understanding the policy, resulting in them failing to implement the policy in their classrooms as required.

For instance, in Namibia, Uugwanga (2015b) claimed that while Namibian science teachers are fully aware of what is expected from them, some teachers are reluctant to change and implement what is stipulated in the Namibian curriculum and some of the challenges are attributed to among other things, lack of subject content knowledge for some teachers, poor teaching strategies, lack of teacher's commitment, issue of time frames and so forth.

Thomas (2012) also found that teachers in Pakistan are pressurised by the system, resulting in them focusing on giving tests and examinations. They also tend to complete the prescribed syllabus and overlook the assessment of the students' knowledge and skills. A study by Yau (2004) reveals that public examination is affecting teaching and assessment strategies. The teachers aim to finish their syllabus and as a result will not use some of the strategies such as formative assessment. In a study conducted in Tanzania, Ndalichako (2015) stated that because of the pressure to reverse the declining trend in performance, teachers use assessment as a tool to prepare students to pass examinations rather than as a tool to enhance teaching and learning. Despite some teachers being trained, they do not use the learner centred approach or use assessment for learning strategies due to the pressure of examinations. Having a good documents policy alone is not sufficient for teachers, thus there is a need to provide strategies to assist teachers to effectively implement them.

2.3.2 Suggestions on how to make Assessment for Learning effective

Kandjeo-Marenga (2008) emphasises that teachers need to be equipped with instructional skills that will enable their students to acquire higher order thinking and practical skills. Agreeing, Thomas (2012) states that teacher education institutes should reconsider their teachings and there should be more professional development activities inside schools to encourage teachers to equip themselves with contemporary approaches of assessments.

A study carried out in South Africa by Jane (2012) recommends that there is a need for a systematic and continuous support to be given to teachers as they attempt to integrate Assessment for Learning in their lessons. Concurring, Florez and Sammons (2013) also suggest that teachers should attend well-developed and recognised professional development programmes that help them to develop a flexible and deep understanding of the sense of the approach. If teachers' professional development is taken seriously, teachers might be equipped with the necessary skills, change in views and attitude toward assessment for learning.

According to Black et al. (2002), collaboration with a group that is trying out similar innovations is essential. Instead of a top down dictate they found that providing teachers with examples of good practice and then inviting them to research assessment for learning classroom practices together was the most effective in both adoption rates and the quality and fit of the solutions. Teachers who are knowledgeable may help those who do not understand. They are in a better position to share ideas, their experience and implementation methods. Hence, Black et al. (2002) emphasise that the support from colleagues is important in overcoming uncertainty, more especially when teachers embark on strategies they are not familiar with such as formative assessment strategies.

2.4 Conceptual framework

A conceptual framework is a synthesis of the existing views in the literature concerning a given situation (Imenda, 2014). Jabareen (2009) defines conceptual framework as a network, or 'a plane,' of interlinked concepts that connect in order to provide an in-depth understanding of a phenomenon or phenomena. Grant and Osanloo (2014) add that a conceptual framework offers a logical structure of connected concepts that help provide a framework of how ideas relate to one another. The concepts are discussed in the following order (1) I first present teachers'

conceptions, followed by (2) teachers' professional development and (3) finally teachers' dispositions.

2.4.1 Teachers' conceptions

Teachers' conceptions are the thoughts, ideas, opinions teachers have with regard to a certain phenomenon. Devlin (2006) defines conceptions as "specific meanings attached to teaching and learning phenomena, which are claimed to then mediate a teacher's view of, and responses to, their teaching context" (p.112).

Teachers' views, conceptions and understanding of assessment have an impact on students' learning as they are likely to influence what the teachers do in the class. Thomas (2012) states that teachers' beliefs affect their choices of assessment strategies. That is, according to Marshall and Drummond (2006), the beliefs teachers hold about learning impact on the way they apply Assessment for Learning in the classroom.

A study carried out in Asia in Brunei Darussalam by Rashid and Jaidin (2014) revealed that teachers hold different conceptions which range from a very basic understanding of assessment of learning (AFL) to a more sophisticated form reflecting deeper understanding. For instance, a number of the participants in their study expressed confusion and uncertainties about what AFL entails and as a result they became less confident in integrating it in their lessons.

Vandeyar and Killen (2007) claim that teachers who view assessment as useful for gathering information, and who use such information to improve learning, will make assessment part of their teaching. There are several factors that influence teachers' conceptions. Jane (2012) points out that the teachers' conceptions of assessment are affected by different factors such as work pressure, overcrowding classrooms, compliance, time management, policy interpretation and implementation, extra administrative workload and paperwork, support from the departmental officials, training and resources.

Jane's (2012) study conducted in South Africa revealed that teachers' conceptions of assessment is influenced by the social and educational context in which they find themselves. Similarly, their personal experiences of assessment also influence their conceptions of assessment. The interaction of beliefs and practices have strong implications for teaching and learning. Echoing the above sentiments, a recent study conducted in Iran revealed that teachers'

use of different methods to assess their students' performances is based on their beliefs about theories of language, teaching, learning and assessment (Moiinvaziri, 2015, p. 75).

One of the factors is the teachers' understanding of assessment. Vandeyar and Killen (2007) point out that teachers cannot use assessment strategies that they do not understand or for which they lack skills. To support this, a study carried out in Tanzania by Ndalichako (2015) also revealed that it is likely that there is a mismatch between what is being reported (teachers' beliefs on assessment) and what is actually practised (implementation of assessment). Kuze and Shumba (2011), in their study conducted in South Africa, noticed that teachers did the opposite of what they actually said formative assessment was. A study carried out in United Kingdom by Harlen and James (1997) confirms that teachers confuse summative and formative assessment. Rashid and Jaidin (2014) thus caution that a very superficial understanding of assessment for learning may have serious implications on the ways in which it is implemented in schools.

In the context of this study, it is hoped that having a thorough understanding of teachers' beliefs of assessment can be of great help to teacher trainers and curriculum designers in fostering the necessary changes in assessment beliefs and practices in an already implemented assessment system as proposed by Moiinvaziri (2015). Jane's (2012) point of view is that unless one interrogates teachers' understanding of assessment practices from instances within their own context and gain their viewpoints as to how these accomplish desirable learning, one may only draw superficial conclusions about their competence and understand little about how to improve less effective teachers. Jane (2012) thus recommends that there is a need for a systematic and continuous support to be given to teachers as they make attempts in integrating AfL in their lessons. That is, there is a need for continuous professional development of science teachers so that they can feel confident about implementing assessment for learning.

2.4.2 Teachers professional development

In her speech at the 4th CPD annual conference (2016), the Namibian Permanent Secretary of the Ministry of Education, Arts and Culture Mrs Sanet Steenkamp, stated that the key strategy that underpins efforts of ensuring access to quality education is the provision of continuous professional development (CPD) of educators. She emphasised that CPD entails teachers engaging in ongoing, and never-ending, or life-long learning that is intended to continuously

sharpen their subject content knowledge and pedagogical skills. This implies that for teachers to meet the demands and to keep up with current changes in education, and to effectively implement assessment for learning strategies during practical activities there is need for on-going teachers' professional development.

In research carried out by Kandjeo-Marenga (2008) she identified that Namibian Biology teachers lack the necessary pedagogic skills to carry out practical activities. Thus, she recommended that teacher education programmes should focus on teaching science teachers how to transform practical tasks and make them accessible to students. Additionally, teachers need skills to encourage learners to become more engaged, to actively participate and take ownership of their own learning as required by the social constructivist perspective (McRobbie & Tobin, 1997; Moll, 2002; Vygotsky, 1978).

The Namibian national curriculum for Education (2009) also highly emphasises and supports lifelong learning. Similarly, the national subject policy guidelines for Natural science subjects in terms of continuous professional development stipulate that:

- To excel as a Natural Science teacher, and constantly to develop teaching and management skills, the teacher should be engaged in continuous training programmes;
- The school should partner and share responsibilities for in-service training of staff members;
- Teachers should share information, experiences and strategies they were equipped with during training; and
- If the necessary expertise for the development of management skills to facilitate creative teaching is absent, then outside help (e.g. Advisory teachers) should be sought.

(Namibia. MOE, 2009, p.8)

This implies the curriculum document recognizes the importance of teacher professional development. This is also emphasised in the document Ministry of Education Strategic plan for 2012-2017 under the strategic theme teaching and learning; the Ministry is aiming at building educators' skills and competencies. In order to provide quality education teachers need to keep abreast with strategies such as assessment for learning in order to improve learning during practical activities.

Several attempts are put in place to develop teachers' professional development. For instance, workshops are conducted by the Senior Education Officer and Training of Trainers (ToT) to

offer support to teachers. In my region, for example, in the subjects that are poorly performed, teachers are given workshops on how to improve the situation.

Another programme which was put in place is the Mathematics and Science Teacher Extension Programme (MASTEP) which was designed as a professional development course that uses distance education, residential workshops and school placements. The primary purpose of the programme is to upgrade science and mathematics teachers trained for lower secondary schooling to enable them to teach effectively. The intended outcomes of MASTEP emphasise a change in teachers' classroom behaviour, rather than just merely a change in their knowledge, skills or attitudes. The programme is thus guided by the philosophy of enhancing teachers' pedagogical content knowledge as stated by Shulman (1987). In the study of Kandjeo-Marenga et al. (2006) on the impact of MASTEP programme, it emerged that there was a difference in teachers' pedagogical skills. The study pointed out that the changes in teaching practices are attributed to the improved PCK that has enabled teachers to align their practice with the assessment system.

On this note, a study conducted in Namibia by Nghipandulwa (2012) highlighted that teachers should be afforded the chance to attend workshops organized by the Ministry of Education and the Advisory Teachers dealing with conducting practicals so that they could develop the skills on how to conduct practical work in Biology. Her study also suggests that the Advisory Teachers should, together with the Ministry of Education, organise workshops and in-service training for Biology teachers in order to train them how to conduct practicals in Biology.

Other scholars such as Iileka (2010), Nghipandulwa (2012), Nyambe (2008) highlighted that there is need for teachers' professional empowerment to improve skills and pedagogy. In relation to my study, Iileka (2012) puts it in more radical terms by pointing out that staff development workshops in the area of formative assessment for teacher educators should be done on a regular basis so that they can develop a common and deeper understanding of the key principles and strategies for formative assessment.

Concurring, Castle (2014) views professional development (PD) as an essential tool designed to address the needs of teachers by providing opportunities for them to build their knowledge of science practices. Thus, teacher professional development is key in teachers understanding of guiding documents such as curriculum. It is also essential in shaping teachers' dispositions.

2.4.3 Teachers' dispositions

In efforts to provide quality and relevant education toward learning theories and pedagogy as reflected in the goals of Ministry of Education, there is need for change in teachers' dispositions, attitudes and views. Schussler, Stooksbery and Bercaw (2010) point out that if the aim is to provide quality education, dispositions have become an important part of the conversation about effective teaching and should be part of the discourse. Villegas (2007) highlighted that the term *dispositions* came into use in the teacher education discourse during the 1990s. However, while many scholars do not use the term dispositions, they speak of diverse qualities that educators must possess (Thompson, 2013). The term disposition can be used to distinguish trends in behaviour from skills, attitudes, traits, and mindless habits and that these distinctions have useful, practical implications even in the absence of desirable precision (Katz, 1993). The terms such as views, beliefs, are used interchangeably and they mean one and the same thing. For the purpose of this study the term that is commonly used is 'disposition'.

Ruitenbergh (2011) points out that the concept of disposition is often unclear in teacher education programs, sometimes being referred to as general personal values and beliefs, and sometimes as professional commitments and actions. Villegas (2007, p.373) offered a working definition of dispositions "that dispositions are tendencies for individuals to act in a particular manner under particular circumstances, based on their beliefs". Disposition is described by Schussler et al. (2010) as a point of convergence, representing a filter through which thinking and behaviours related to teaching are framed, and a point of inception, from which knowledge and behaviours emanate. To Atallah, Bryant and Dada (2010), dispositions as regarded as the beliefs or tendencies to exhibit a frequent, conscious and voluntary behaviour directed towards learning a subject.

According to Katz (1993), there are several reasons for suggesting that dispositions should be included among educational goals.

- Teaching practices should take into account ways that the dispositions associated with skills can be strengthened;
- Second, dispositional considerations are important because the instructional processes by which some knowledge and skills are acquired may themselves damage or undermine the disposition to use them;

- Third, some important dispositions relevant to education, such as the disposition to investigate, may be thought of as inborn; and
- Fourth, the processes of selecting curriculum and teaching strategies should include considerations of how desirable dispositions can be strengthened and undesirable dispositions can be weakened. Therefore, when selecting teaching practices, opportunities for children to exhibit desirable dispositions should be considered (pp. 2-3).

Villegas (2007) advises that to maximize the impact of formal preparation on teacher learning, teacher educators must create ample opportunities early in the program for candidates to examine critically their taken-for-granted beliefs in relation to classroom actions. Schussler et al. (2010) argue that teacher education programs can foster dispositions by helping teacher candidates engage in self-exploration of their personal theories and identify their own values and assumptions related to teaching. In addition, Schussler et al. (2010) argue that teacher education programs can foster dispositions by helping teacher candidates engage in self-exploration of their personal theories and identify their own values and assumptions related to teaching. To this end, Thompson (2013) notes that the practice of assessing the dispositions of pre-service educators has gained increasing attention among institutions of teacher preparation.

2.5 Theoretical framework

A theoretical framework refers to the “application of a theory or a set of concepts drawn from one and the same theory” (Imenda, 2014, p.189). It is the scholarly structure which guides the study and informs how the researcher will view data gathered. As Troudi (2014) contends, the purpose of a theoretical framework provides a researcher position *vis-à-vis* the issue being studied and his/her stand on the literature. In addition, the theoretical framework informs the data analysis process. This study is underpinned by a combination of two theories; Vygotsky’s (1978) social constructivist learning theory and Shulman’s (1986) Pedagogical Content Knowledge (PCK). I now discuss these in detail below.

2.5.1 Social constructivism

Learning occurs in a social context. According to Vygotsky (1978), learning happens through social interaction via parents, teachers and other knowledgeable adults. Social interactions

within the learning environment are an essential part and contribute to individual learning (Jaworski, 2006). It regards all our cultural artefacts, knowledge, practices, institutions, indeed everything, as relative to and “constructed by” this-or-that culture specific form of life, language game, paradigm, conceptual framework, interpretive community, or whatever (Moll, 2002, p.19).

McRobbie and Tobin (1997) explain social constructivism as meaning constructed by individuals as new information interacts with their extant knowledge. Although a learning environment is necessarily personal, each individual’s construction is mediated by the actions of others in a social setting and characteristic of the culture in which learning is situated.

Applying this to teaching and learning during practical science activities we can imagine the process where the teachers interacts with the learners during practical activities. The teacher thus takes the role as a facilitator and assists learners to achieve the intended basic competencies and understandings. During this process the learners are asked questions and given feedback to improve and are able to work on their weak points. There is interaction between the teacher and learners as well interaction between learners and learners (Stott, 2016). Palinscar (1998) further points out that from a social constructivist perspective, interactions such as those achieved through classroom discussions are thought to provide mechanisms for enhancing higher order thinking. In this study, high order thinking will be enabled when engaging in discussions and participants asking quality questions.

For example, in this study hands-on practical activities were carried out while learners were sitting in groups. This meant that those learners that know could explain and assist others. Thus, social interaction is very essential as reiterated by Vygotsky (1978). It is also through classroom discussion that learners can learn from each other. Palniscar (1998) points out that assessment practices informed by social constructivist perspective are frequently referred to as dynamic assessment and characterize approaches in which the performance of the individual being assessed is mediated or guided by another individual to determine the individual potential to profit from assistance or instruction.

The continuation of interaction, assisting the less knowledgeable and the interaction among themselves is what is described by Vygotsky as the zone of proximal development (ZPD) and I discuss this below.

- *Zone of proximal development*

Vygotsky (1978) developed a theory of zone of proximal development (ZPD). Vygotsky views the ZPD as the gap that exists when a learner learns individually and when learners are provided with assistance from a knowledgeable adult or provided with assistance from others. He thus defined the ZPD “as the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” (Vygotsky, 1978, p. 86).

I now look at how teachers conceive of ZPD during practical activities. This implies that learners have the knowledge they came with and there are tasks that they can do on their own.

The assistance of the teachers during the conducting of practical activities means that learners can learn from the teacher who is more knowledgeable than themselves, and that during practical activities learners can work together and learn from each other. From my understanding teachers should be knowledgeable so that they are able to give right information to learners. During practical activities the teacher can use ZPD and scaffolding by placing learners who understand in same group as those who need assistance so that they can help each other. The teachers should also understand learners’ background so that they are able to use this information to move learners from what they already know into new advanced knowledge. For instance, scaffolding is emphasised when the teachers ask questions, learners respond and the teacher gives feedback based on learners’ responses.

In professional development one needs to consider the ZPD and scaffolding of teachers themselves in their learning and how this might play out in teachers’ exposure to ideas and practices in an intervention workshop and thereafter. Teachers have knowledge that they have acquired. However they need assistance with adopting new pedagogy that can improve learners understanding.

Of course in their own classrooms ZPD is also central as learners have and acquire knowledge and there are those activities that in time they can and should do on their own. The teachers need to adopt scaffolding and mediation strategies to make this happen. The role of assessment for learning within the ZPD classroom processes and lesson timeframe offers some key, if not essential, tools in this process including assessing understanding, providing feedback an opportunities to correct and move forward. Teachers use the information from learners to feed

forward until reaching a stage where learners are able to do activities on their own without the teacher's guidance. In terms of practical activities, learners might not be used to predicting, explaining and engaging in discussions. Given time, as the learners are assisted they will improve.

Of course for the teacher to effectively scaffold she needs to also have a good understanding of the subject and of pedagogical content knowledge. In the next section I discuss pedagogical content knowledge as one of the theoretical frameworks.

2.5.2 Pedagogical content knowledge

Since this study deals with a set of pedagogic strategies or practices, viz., assessment for learning, within a particular subject context and subject content, science practical work in particular, which is a central process for thinking and doing science; then a learning model that combines both pedagogy and content is what is needed. The study is thus grounded in Shulman's (1987) framework of Pedagogical Content Knowledge (PCK). Shulman (1987) understands PCK as representing the blending of content and pedagogy. Lending support, Cochran, DeRuiter and King (1993) define PCK as a type of knowledge that is unique to teachers, and in fact is what teaching is about. It concerns the manner in which teachers relate their pedagogical knowledge (what they know about teaching) to their subject matter knowledge (what they know about what they teach), in the school context, for the teaching of specific students. It is the integration or the synthesis of teachers' pedagogical knowledge and their subject matter knowledge that comprises pedagogical content knowledge.

Shulman (1987) adds that a teacher may know something not understood by others, presumably the students. Herein lies the importance of the more knowledgeable one as espoused by Vygotsky (1978). The knowledgeable teacher can transform understanding, performance skills, or desired attitudes or values into pedagogical representations and actions. Ball (2000) posits that subject matter and pedagogy have been peculiarly and persistently divided in the conceptualization and curriculum of teacher education and learning to teach. This fragmentation of practice leaves teachers on their own with the challenge of integrating subject matter knowledge and pedagogy in the contexts of their work.

In the context of this study, it was assumed that the teachers involved had content knowledge but may lack the pedagogic content knowledge. Ndalichako (2015) cautions teachers are expected to play a dual role, one is to have knowledge of the subject and to have knowledge of

pedagogies. For the purpose of this study an intervention workshop was designed and implemented to strengthen teacher pedagogical knowledge. Hence, teachers needed to play the role of implementing assessment for learning. Teachers' PCK can be enhanced if they are involved in training and workshops for the teachers to learn how to ask learners questions that will enable learners to think.

2.6 Concluding remarks

The aim of this chapter was to review literature related to assessment. The chapter started by highlighting learner centred education and assessment as reflected in the Namibian curriculum. In addition, the chapter reviewed literature on assessment for learning by focusing on strategies such as questioning, giving feedback, learning goal and peer assessment. Further, factors that inhibit effective implementation of assessment for learning are highlighted. The chapter ends describing the theoretical framework underpinning the study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The main goal of this research study was to investigate science teachers' conceptions of and dispositions towards the implementation of assessment for learning (formative assessment) during science practical activities. In this chapter I discuss the research design and methodology employed to gather data. This includes the research paradigm, research goal and questions, research site and sampling. I also describe the different data gathering techniques and their relevancy to my study. In addition, the process of data preparation and data analysis are described. The chapter ends with the discussion of validity and trustworthiness as well as ethical considerations.

3.2 Research design and orientation

In this section I will discuss the research orientation, the research design as well as the research approach I used in the study. I will start off describing the research orientation.

3.2.1 Research orientation

This study is underpinned by an interpretive paradigm. In the interpretive paradigm, researchers do not aim to predict what people will do, but rather to describe and understand how people make sense of their worlds and how they make meaning of particular actions (Bertram & Christiansen, 2015). The purpose is to develop a greater understanding of how people make sense of contexts in which they live and work. Cohen, Manion and Morrison (2011) point out that the central endeavour in the context of the interpretive paradigm is to understand the subjective world of human experience. This means trying to understand the person from within. In the context of this study, I was interested to understand how science teachers are implementing the use of formative assessment or AfL during science practical activities and identifying the challenges they face. The interpretive paradigm enabled me to understand the individuals and set out to understand their interpretation of the world around them (Cohen et al., 2011).

3.2.2 Case study

Within the interpretive paradigm, a case study approach was adopted. A case study provides a unique example of real people in real situations, enabling readers to understand ideas more clearly than simply by presenting them with abstract theories or principles (Cohen et al., 2011).

Echoing the above statement, case studies are primarily developed with the aim to describe ‘what it is like’ to be in a particular situation, so they are generally descriptive in nature; however they can also be used to generate claims for further verification (Bertram & Christiansen, 2015).

In addition, in order to fully understand teachers’ conceptions and dispositions, this study employed a mixed method approach. A mixed method approach incorporates elements of both quantitative and qualitative data (Creswell, 2014). A quantitative approach is one in which the researcher primarily uses positivist claims for developing knowledge by employing strategies such as survey or questionnaires to collect statistical data. Whereas a qualitative approach is the one in which the researcher make knowledge claims based on constructivist’s perspective.

Johnson and Onwuegbuzie (2004) emphasise that the benefit of mixed methods research is that it can provide stronger evidence for a conclusion through convergence and corroboration of findings as it can assist to answer a broader range of research questions than either qualitative or quantitative methods alone. However, in a recent study, Bentahar and Cameron (2015) highlighted that a mixed method is still underutilized for reasons such as time, money, and the capacity to use the two methods, thus many researchers resort to using only a mono method.

3.3 Research goal and objectives

The main goal of this research study was to investigate science teachers’ conceptions of and dispositions towards the implementation of assessment for learning (formative assessment) during science practical activities.

To achieve this goal a set of research objectives have been formulated as follows:

3.3.1 Research Objectives

The objectives of this study are to:

- Find out science teachers’ conceptions of assessment for learning (formative assessment);
- Find out how science teachers make use of assessment for learning;
- To explore how an intervention in the form of a workshop on assessment for learning during science practical activities influences teachers’ dispositions; and
- To identify factors that enable/constrain the implementation of assessment for learning during science practical activities.

To realise this main goal and objectives, the study was guided by the following research questions:

3.3.2 Research questions

What are science teachers' conceptions of, and dispositions towards, the implementation of assessment for learning (formative assessment) during science practical lessons?

The following sub-questions were answered:

Phase I: Baseline study

1. (a) What are science teachers' views and experiences of the implementation of assessment for learning (AfL) during science practical lessons?
- (b) What factors influence the science teachers' views and experiences on the use of assessment for learning (formative assessment) during science practical activities/work?

Phase II: Intervention orientation workshop on Assessment for learning strategies

2. How does the intervention in the form of a workshop on Assessment for Learning (AfL) influence science teachers' conceptions and dispositions towards the use of Assessment for Learning (AfL)?

Phase III: Implementation of Assessment for Learning strategies in the classroom

3. How do science teachers make use of Assessment for Learning (AfL) during their practical activities?
4. What factors enable and/or constrain science teachers' conceptions and dispositions towards the implementation of Assessment for Learning (AfL) during their science practical lessons?

3.4 Research sites and sampling

As mentioned earlier, the study took place in three phases. Thus the sites were also different. For Phase I and II the research site was similar while for Phase III the site was different. I thus discuss the research sites.

3.4.1 Research sites

For Phases I and II, the study took place at the Namibian Institution for Educational Development (NIED) situated in Okahandja, Otjozondjupa region (see Figure 1 for the location of sites). The participants attended their face-to-face contact session at NIED, Okahandja with a South African University. Apart from being a centre to attend classes, NIED is a centre established in 1990 as a curriculum development centre with a responsibility for spear-heading Basic Education reform and development. NIED is also responsible for curriculum design and development; as well as co-ordination of continuing professional development of educators.

For Phase III, the research took place in Omusati region of Namibia. The study took place at two government schools. Figure 1 shows the location of Omusati region. Omusati region is found on the northern part of Namibia, near the Angola border. The schools are located in a rural area and learners reside in a village and have to travel about 5km to come to school. Learners from both schools speak Oshiwambo at home. Neither school has a fully functioning laboratory, however they use their classrooms to conduct practical activities.

A map showing the regional research site

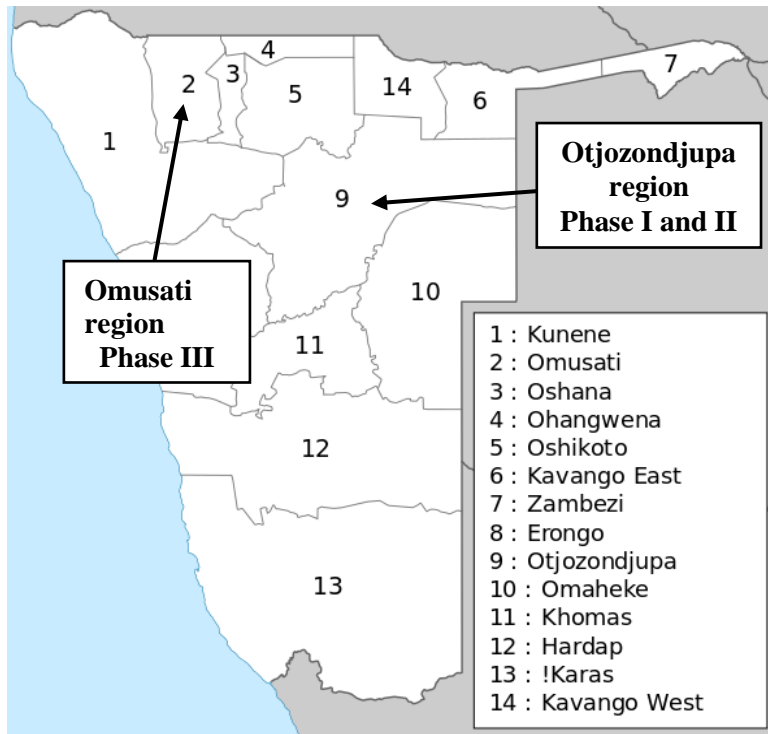


Figure 1: Regions of Namibia

Source: https://commons.wikimedia.org/wiki/File:Namibia_14_regions-numbered.svg retrieved on 29 September 2016

3.4.2 Sampling

According to Bertram and Christiansen (2015), sampling involves making decisions about which people, settings, events or behaviours to include in the study. Phases I and II of the study were conducted in Otjozondupa region, Namibia. The study involved a total of twenty five (25) postgraduate students who were doing the BEd (Hons) Science Elective course with a South African University. The twenty six participants teach a range of different science subjects, namely, Life Science Grade 8-10 (four teachers), Natural Science and Health Education Grade 5-7 (nine teachers), Biology Grade 11-12 (three teachers), Physical Science Grade 8-12 (twelve teachers) as well as Agricultural Science Grade 8-12 (four teachers). Apart from science subjects two of the participants only teach Mathematics although they have studied science at college level.

From this group, I purposively selected two Life Science/Biology teachers to observe as they implemented Assessment for Learning strategies, and to interview afterwards to reflect on what transpired. As alluded to by Bertram and Christiansen (2015), with purposive sampling the researcher makes specific choices about which people, groups or objects to include in the sample. I selected Life Science because that is the subject I also teach.

After purposively selecting two teachers, Phase III of the research was conducted in Omusati region. The selection of the two participants was based on factors such as proximity and their willingness to partake in the study. They volunteered to be observed. It was necessary to take participants from Omusati region because a total 11 out of 25 teachers teach there and the researcher is also a teacher in the aforementioned region. This sampling was convenience sampling. Bertram and Christiansen (2015) stated that, “convenience is choosing a sample which is easy for the researcher to reach”. It was convenient because as a researcher I reside and teach in Omusati region. It was also convenient for me and the participants to meet NIED for follow up and interviews as the session take place at the same time.

3.5 Data gathering techniques

In this study I used questionnaires, observations, semi-structured interviews and reflections. Using different strategies enabled me to triangulate data. Table 2 outlines how the different techniques were used at each phase.

Table 2: Different phase and different techniques

Phases	Data gathering technique used	Purpose and the type of data to be collected
Phase I: Baseline data	(a) Questionnaires	Teachers conceptions and experiences of assessment; <ul style="list-style-type: none"> To get insight into science teachers conception and experiences toward assessment
Phase II: Intervention workshop on Assessment for Learning	(a) Observation	Demonstration on how to make use of Assessment for Learning; <ul style="list-style-type: none"> To observe the co-researchers as she demonstrate to participants how to implement Assessment for Learning during practical activities using easily accessible materials
	(b) Reflection	<ul style="list-style-type: none"> To reflect on what took place during the Intervention workshop After being exposed to principle of Assessment for Learning Assess teachers' dispositions after the workshop
Phase III: Classroom implementation of Assessment for Learning	(a) Observation	<ul style="list-style-type: none"> To observe teachers as they implement Assessment for Learning strategies during practical activities Identify factors that enable or constrain as they implement
	(b) Post reflective interview	<ul style="list-style-type: none"> Teachers to reflect on what transpired as they were implementing

Below, I describe each technique and how they apply in the study.

3.5.1 Questionnaires

The data gathering process commenced with a questionnaire that was used to obtain information about teachers' conceptions toward Assessment for Learning (Formative Assessment) in science classrooms and their use of assessment in practical science lessons in particular. The purpose and approach was explained as Cohen, et al. (2011) point out that the purpose of questionnaires must be clarified and then translated into a specific tangible aim or set of aims.

The questionnaire had both closed and open-ended questions. Cohen, et al. (2011) affirm that open-ended questionnaires enable respondents to answer as they wish. The questionnaire was divided into three sections (see Appendix 3A). The first section of the questionnaire, Part A, was aimed to document teachers' information such as age, gender, region where they are teaching, current position, qualification etc. Parts B and C of the questionnaire intended to find out teachers' beliefs and attitudes toward Formative Assessment/AfL. As a result of having

open ended questions and close ended questions data from the questionnaire were presented as quantitative and qualitative data. The questionnaires were administered during the January contact session in 2016.

As participants were completing the questionnaire they were allowed to ask about anything they did not understand. All questionnaires handed to the participants were returned. The data from the questionnaires informed me about the type of conceptions and experiences teachers have and this helped me to decide on what to include in Phase II of the study. I also realised that by having participants gathered at one place to complete the questionnaire there was a high chance of getting all the questionnaires back, unlike sending out questionnaire and only getting a few back.

3.5.2 Observations

One of the major data techniques used in the study was observation. Cohen et al. (2011) posit that observations offer the researcher the opportunity to gather ‘live’ data from naturally occurring social situations. The observation was also accompanied by photographs and video recording. Observation took place during Phase II and III. I thus describe observation for Phase II and for Phase III

- **Phase II: Observation of the Intervention workshop**

I was a participant observer for five days. Yin (2003) explains that participant observation is a special mode of observation in which you are not merely passive but instead assume a variety of roles and may actually participate in the events being studied. I observed the co-researcher demonstrating how to implement Assessment for Learning strategies. A variety of practical activities were conducted from Monday up to Friday. The central ideas for the co-researcher as observed was to demonstrate to participants the following:

- Demonstrate to participants that a variety of locally available materials can be used to do experiments;
- Communicate clear learning goals during practical activities as a strategy for AfL;
- Demonstrate to participants how to use questioning as a strategy for Assessment for Learning, this entails asking quality question that enable participants to think;
- Demonstrate to participants how to give immediate feedback;
- She also encouraged social interaction among participants so that they learn from each other during group works; and

- Encourage active engagement during practical activities;
- To show that doing practical activity in the right way can be fun;
- To instil confidence among the participants so that they do the activities with their learners; and
- To inspire the participants to think out of the box for other practicals that they can do to improve teaching and learning.

As observed, the activities were interesting and at the same time the participants learned a lot from them. All the practical activities started with the presenter stating the learning goals. The participants were actively involved by doing most of the tasks themselves with the assistance of others. The participants tried answering questions as well as asking questions. The participants completed worksheets where they were expected to predict and provide explanation. By the end of each practical activity the participants had to come up with mind-maps and concept maps.

Table 3: Description of practical activities carried out during the Intervention workshop

<ul style="list-style-type: none"> ▪ Practical activity about fermentation, making of a traditional drink called <i>Oshikundu</i> to produce carbon dioxide ▪ Preparation of eggs in different solutions (Pure water, Coke cooldrink, lemon juice and vinegar) ▪ Practical activity about Osmosis by adding potatoes in sugar solution, salt solution and pure water ▪ Practical activity on rate of diffusion using tea bags and place them in warm and cold water ▪ Testing for the presence of carbon dioxide using exhaled air ▪ Testing for the presence of carbon dioxide using yeast and sugar ▪ Testing for the presence of carbon dioxide using vinegar and bicarbonate of soda ▪ Testing for the presence of carbon dioxide using egg shells and an acid ▪ Making hydrogen gas using caustic soda ▪ Practical activity on atmospheric pressure- Collapsing can

The observation was strengthened by using a video recorder and photographs. A colleague assisted by taking videos for the entire session. I learned that video recording enabled me to go over the lesson again and get a better understanding of what was taking place during the intervention.

- **Phase III Classroom practice observation**

I had an opportunity to observe two teachers as they implemented assessment for learning strategies during practical activities. As the participants teach Life science they opted to do practical that are related to their subjects. The following practicals were carried out by both teachers (1) The practical activity on fermentation using a local drink called *Oshikundu*, (2) adding the eggs in different solutions to use the egg as an animal cell (3) Practical activity on osmosis placing potatoes in different solutions, and (4) testing the presence of carbon dioxide using exhaled air.

The teachers planned the worksheet for the learners to the level of the learners with guidance from the worksheet they had received during their workshop. The participants then asked for assistance as they were not sure of some of the aspects.

By the end of each task the teachers ensured that learners had listed the emerging concepts from each of the practical activities and had come up with mind maps. It was observed that learners struggled with the predicting and observing during the first activities but there was an improvement with the other practical activities that followed.

3.5.3 Interviews

Cohen, et al. (2011) see interviews as “enabling participants to discuss their interpretations of the world in which they live, and to express how they regard situations from their own point of view” (p. 411). Turner (2010) is of the opinion that interviews provide in-depth information pertaining to participant’s experiences and viewpoints of a particular topic. I conducted a semi-structured interview at the end of Phase III, which is after the teachers have implemented assessment for learning strategies. I used my research question to guide the semi-structured interview. Although the interview questions were formulated before the interview, it provided an opportunity for teachers to reflect on what had worked during the implementation and the challenges they experienced. By using interviews it was possible to get deeper insight into the factors that enabled or constrained teachers’ implementation of assessment for learning.

According to Cohen and Crabtree (2006), semi-structured interviews also allow informants the freedom to express their views in their own terms and can provide reliable, comparable qualitative data. A semi-structured interview was suitable for this study to complement information gathered from observation. The interview was conducted in the afternoon, on a day the participants were free and available. The interview was planned to last for 30 minutes. With the permission from both participants the interviews were tape recorded. The interviews were conducted in English. Both interviews took place at the participant's school in their classrooms. The interviews were recorded and later transcribed. By using a semi-structured interview I have learnt that it is an opportunity to confirm what was happening during observation. For instance, during observation I observed the teachers using the assessment for learning strategies. The interviews gave an opportunity for the participants to confirm the enablers and challenges.

3.5.4 Reflections

After the intervention workshop, participants were given an opportunity to reflect on their experiences. Fook (2011) describes critical reflection as an overall process of making meaning from experience with a purpose to improve practice. The participants' reflections gave me some insight on their attitude and disposition after being exposed to the intervention workshop and their current disposition toward assessment. Furthermore, it is through engaging with reflections that peoples stories change in a relatively short time through critical reflection.

Lastly, one of the challenges I have experienced is trying to manage a variety of data gathering techniques.

3.6 Data collection procedure

Based on the data gathering techniques, my research followed the steps illustrated below:

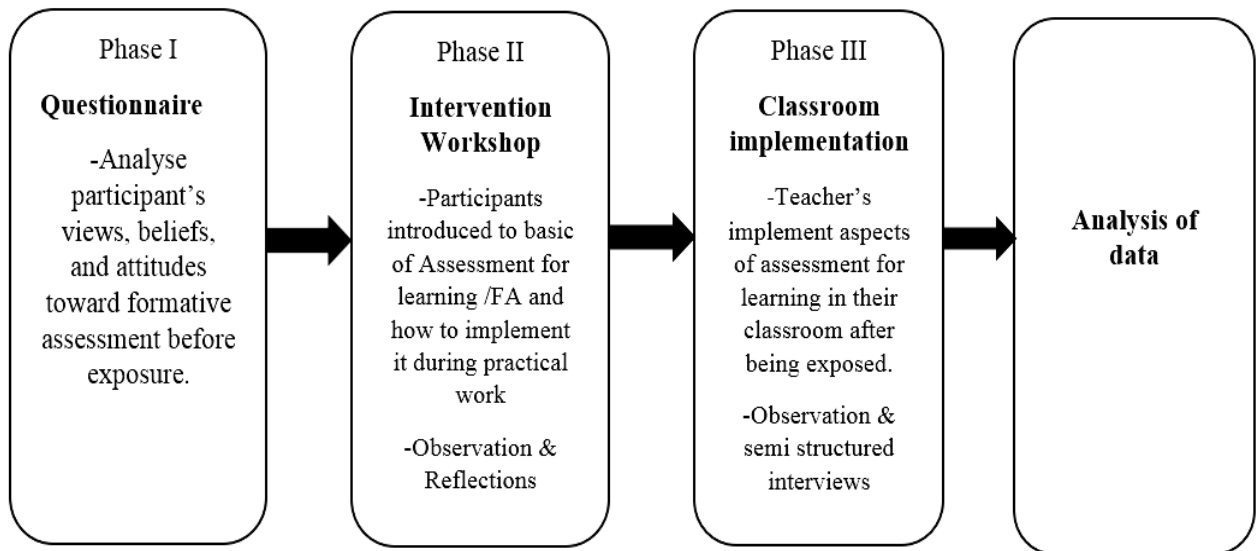


Figure 2: Data collection procedures

In line with figure 2, the research followed the following stages as explained below:

Phase I – Baseline study

- To identify the type and nature of teachers conceptions teachers hold by using a questionnaire; and
- Analyse the questionnaires to understand teachers’ views and experience of assessment in the teaching and learning of science.

Phase II- Intervention Orientation workshop on Assessment for Learning

- Plan an Intervention workshop on how to integrate assessment for learning during practical activities;
- The intervention workshop followed the steps below:

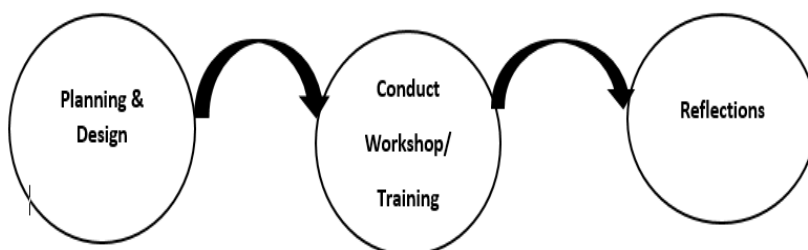


Figure 3: Steps taken throughout the workshop

- The researchers planned for the activities to be done together. In addition, we co-designed the worksheets for the participants. The Intervention workshop consisted of a series of practical activities.
- Handouts for students were prepared in advance.
- Conduct an intervention for a week where participants are exposed to
 - (i) The use of easily accessible materials
 - (ii) The use of assessment for learning strategies within a practical investigation
- Participants reflect on their experience of workshop.

Phase III- Classroom practice

- Participants to implement the activities carried out back to their schools.
- I had the opportunity to observe two participants.

3.7 Data analysis

According to Christiansen and Bertram (2015), data analysis means a close or systematic study, or the separation of a whole into its parts, for the purpose of study. The first stage before data analysis was to transcribe and collate data from questionnaires, interviews and reflections. Burnard, Gill, Stewart, Treasure and Chadwick (2008) posit that there are two fundamental approaches to analysing qualitative data (although each can be handled in a variety of different ways): the deductive approach and the inductive approach. The analysis of this study followed an inductive approach.

Futhermore, the inductive approach involves analysing data with little or no predetermined theory, structure or framework and uses the actual data itself to derive the structure of analysis (Burnard, et al., 2008).

The next step was to read through the data over and over again in order to make sense of it. I read through the data and underlined important ideas. After underlining, I read through again for the second time, and a third time to mark texts related to each other in a similar colour. This was followed by categorising data into sub-themes and themes. New categories or subthemes

that emerged when the data was reread that were skipped when I read for the first time. I suggest it is necessary to go through the data several times.

For Phase I of the study the data from the questionnaire was categorised into quantitative and qualitative data. Quantitative data were presented in tables and graphs and analysis was based on the difference and similarities that appear. For qualitative data from the questionnaire data were categorised into emerging themes.

For Phases II and III, the data collected from this study were analysed using a thematic approach. Based on the data, I developed themes and categories. The emerging themes were analysed based on the theoretical framework. I used Shulman's (1987) PCK as a theoretical framework to look into teachers' views, conceptions and attitude and experiences. In addition, I also used Vygotsky's (1978) social constructivism to analyse the data. I used social constructivism as a lens to look at the interactions that took place during the practical activities. Themes were also analysed based on Vygotsky's social interactions. The themes identified in Phase II were also applied to the data from Phase III.

3.8 Validity and Trustworthiness

Bertram and Christiansen (2015) define validity as something that is sound and justifiable. This study ensured validity and trustworthiness by employing the following validation techniques: triangulation, member checking and stimulated recall interviews. One way to ensure validity is to adopt a triangulation process (Maxwell, 2009). According to Creswell and Miller (2000), triangulation is a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study. Triangulation is collecting information from a diverse range of individuals and settings using a variety of tools. In this research the tools include data collected from questionnaires, stimulated recall interviews, video recordings as well as reflections. Triangulation reduces the risk of chance associations and systematic biases due to a specific method and allows a better assessment of the generality of the explanations that one develops (Maxwell, 2008). Rossouw (2003) contends that triangulation serves as a confirmation of the data by using more than one method of data collection, more than one source of data, more than one method of data analysis, more than one researcher, and more than one perspective.

In addition, I also gave participants the interview transcript to verify and add any information that was necessary. Lastly, to ensure validity of the data I presented my preliminary data at the Eastern Cape SAARMSTE colloquium in South Africa where other researchers gave comments and suggestions. I believed being granted an opportunity to present at the colloquium enabled me not to be biased when presenting and analysing my data.

3.9 Ethical considerations

A research study has to conform to certain ethical consideration. This includes researcher positionality, respect and dignity, transparency and honesty, accountability and responsibility, integrity and academic professionalism. In this section, I thus discuss how I adhered to ethical issues below:

- Prior to the commencement of this study, a research proposal was submitted to the University's Education High Degrees Committee (EHDC) for approval. After the proposal was approved by the EHDC, permission from the relevant authorities such as the Ministry of Education (Omusati Education Directorate), the participants and the school principals of the two teachers that I observed was sought.
- **Respect and dignity:** All the participants participated voluntarily and they had freedom to withdraw anytime if they so wished (Bertram & Christiansen, 2015); however none withdraw. Furthermore, participants' autonomy was respected. In order to ensure that respect of the participants, I asked for permission to take pictures and to video-record the lesson. All the participants agreed to be recorded. I also ensured that the participants' name and school name would not be revealed in the thesis as they have the right to remain anonymous. However, participants were given an opportunity to give themselves a pseudonym and also to assign pseudonyms for their school. For instance teacher 1, chose the name Rumbidzai and her school name is Rudo JS, while teacher 2 chose the name is Mrs Delizia and her school name is Rufaro JS. Lastly, all the data will be stored and information gathered will not be shared, in order to protect the privacy of the participants.
- **Transparency and honesty:** Participants were informed about the purpose of the research. Before commencing of the study, discussions were held between the researcher and the participants to negotiate and explain what the study entails, thereafter the consent forms were explained and the participants signed the consent forms. For transparency purposes

participants were granted an opportunity to verify data from the interviews, thus, data from interviews were shared with participants to ensure that they were valid.

- **Accountability and responsibility:** As a Master of Education student and a researcher with the BEd Hons students I am fully aware of the power relations that exist and I was considerate of my position.
- **Researcher positionality:** An attempt to address issues of power gradient or positionality that might arise between the BEd (Hons) Science Elective students and us (the two collaborating researchers who are doing Masters in Science Education), a good rapport and trust was developed during the first January session in 2016. Karnielli-Miller, Stier and Pessach (2009) point out that power relations falls under different stages, during the initial stage control over research lies in the hand of the researcher, who decides how to introduce the research to potential participants, how to describe research goals and how to disclose institutional affiliation to maximize cooperation. It is therefore for these reasons that during the January session, a discussion about the research goals and benefits of the study took place and then consensus was reached between the two parties. The participants signed consent letters to indicate their commitment and willingness to take part in the study. The informed consent contained the research title and goal and details of what the study entailed (See Appendix 1A). Cohen, et al. (2011) suggest that informed consent reinforces asymmetries of power between researchers and participants, rather than equalizing them.
- **Integrity and academic professionalism:** Participants were respected throughout this research. I ensured that the data collected are true and valid. Triangulation was used to ensure validity. Member checking was also done. The data collected will be kept for future references in a project archive. I adhere to the University references guidelines and where works of others is used I have acknowledged it.

3.10 Limitations

The study was carried out with a special group of people who are the BEd (Honours) Science Elective students. Additionally, the study was only carried out at two schools and so the

findings of the study cannot be generalized. However, some insights were obtained from the study into how teachers implement assessment for learning strategies during practical activities. Another limitation during the first practical activity was that the camera man assigned to video the first session failed to operate the camera and we only came to realise that after the session. Fortunately I could rely on some video and audio clips that I took.

3.11 Concluding remarks

In this chapter I have described the research design and orientation. The study is underpinned within an interpretive paradigm. I stated the research goal, research objectives, main research questions and the sub-questions. The chapter described the research site and participants for both phases. The data gathering techniques used to gather the data are described. The chapter described how data were analysed. Lastly, issues of validity and ethical consideration are highlighted. The chapter ends by stating the limitations of the study.

In the next chapter I present, analyse and discuss data from Phase I of the study and discuss it in relation to literature and theory.

CHAPTER 4: DATA PRESENTATION, ANALYSIS AND DISCUSSION (PHASE I)

4.1 Introduction

The goal of this study was to investigate Science teachers' conceptions of, and dispositions towards, the implementation of Assessment for Learning (Formative Assessment) during science practical activities. As stipulated in Chapter 3, the study is segmented into three phases. Research findings are also presented in three different chapters.

This chapter thus presents data for Phase I. The data presented in this chapter emanated from the questionnaires which were administered to 25 teachers enrolled for the Bachelor of Education degree (honours) run by a university from South Africa. The questionnaire is divided into three sections (see Appendix 3), that is, (1) the teachers' profile (2) teachers' existing beliefs about the role of formative assessment (Assessment for Learning) and (3) teachers' perceived factors that enable and constrain the implementation of formative assessment. The following research sub-questions are addressed in this chapter:

- What are science teachers' views and experiences of the implementation of Assessment for Learning during science practical lessons?
- What factors influence science teachers' conceptions and dispositions towards the implementation of Assessment for Learning during science practical lessons?

4.2 Quantitative data from questionnaires

A total of 25 questionnaires were distributed and administered to the teachers during the contact session in January 2016. The intention of the questionnaire was to assess teachers' existing beliefs toward Assessment for Learning (Formative Assessment) as the literature emphasises that teachers' beliefs and conceptions affect the way they teach (Marshall & Drummond, 2006). As I administered the questionnaires to these teachers, they had an opportunity to ask for clarifications whenever they did not understand certain questions. All questionnaires were filled and returned to me on the same day.

4.2.1 Teachers' profiles

In order to fully understand the study there is a need to understand the background of the participants. Different codes were used to label the participants. For example, T represents teachers and Q represents a questionnaire. In addition, the codes used indicate the gender of the participants where M is for Male and F is for a Female. For example, T₁Q₁F is a female teacher with questionnaire labelled number 1 while T₂Q₂M is a male teacher with questionnaire labelled number two and so on.

4.2.1.1 Teachers' genders

As indicated in Figure 4, 16 (64%) participants were male teachers and only 9 (36%) were female teachers. Thus, male teachers were in the majority in this BEd (Hons) Science Elective class.

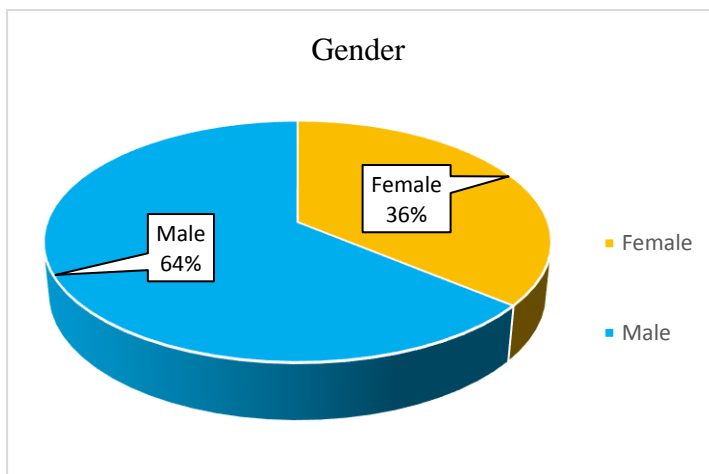


Figure 4: Gender of teachers involved during Phase I

4.2.1.2 Teachers' age ranges

Table 4 below indicates that the teachers' age range is from 20 years up to the age of 45 years. The majority of the teachers (52%) are between the ages of 26 up to 30. However, no participants were above the age of 46. This suggests that the participants in this study were young teachers.

Table 4: Teachers' age range

Age Category	Teachers' code	Frequency
20-25	T ₆ Q ₆ M	1
26-30	T ₁ Q ₁ F, T ₄ Q ₄ F, T ₈ Q ₈ M T ₉ Q ₉ M, T ₁₁ Q ₁₁ M T ₁₂ Q ₁₂ F, T ₁₃ Q ₁₃ F, T ₁₆ Q ₁₆ M, T ₁₉ Q ₁₉ M, T ₂₂ Q ₂₂ M, T ₂₃ Q ₂₃ M, T ₂₅ Q ₂₅ F	12
31-35	T ₂ Q ₂ M, T ₃ Q ₃ F, T ₇ Q ₇ M, T ₁₅ Q ₁₅ F, T ₁₇ Q ₁₇ M, T ₁₈ Q ₁₈ M, T ₂₀ Q ₂₀ F, T ₂₁ Q ₂₁ F	8
36-40	T ₅ Q ₅ M, T ₁₀ Q ₁₀ M, T ₂₄ Q ₂₄ M	3
41-45	T ₁₄ Q ₁₄ M	1
46- <50	none	0
Total		25

4.2.1.3 Regions where teachers are currently teaching

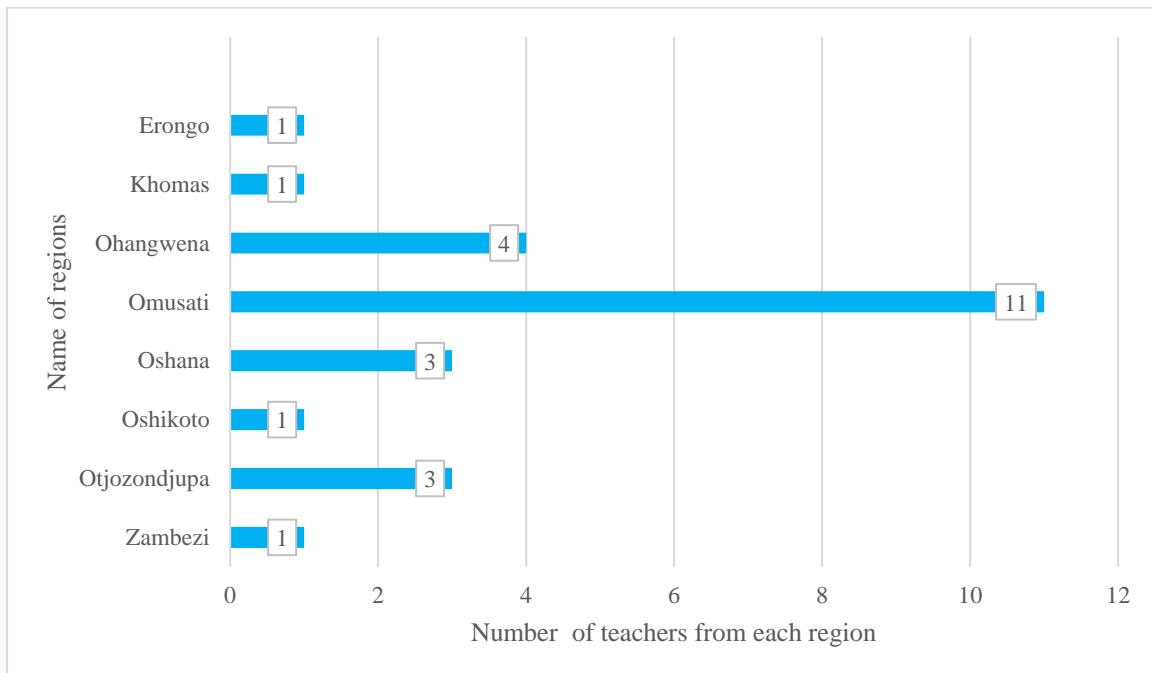


Figure 5: The number of teachers from the region they are currently teaching

This graph shows that the participants in this study hail from different regions of Namibia such as Erongo, Khomas, Ohangwena, Omusati, Oshana, Oshikoto, Otjozondjupa and Zambezi region. However, 11 out of 25 teachers (44%) are teaching in the Omusati region.

4.2.1.4 Teachers' current positions, qualifications and subjects currently taught

Table 5 below shows that participants either hold a Basic Education Teacher Diploma (BETD) or a Diploma in Education. In addition to their first qualification, they also obtained an Advanced Certificate in Education (ACE) or an Advanced Diploma in Education (ADE). The participants teach a range of science subjects such as Physical Science Grade 8-10, Biology Grade 11-12, Life Science Grade 8-10, Natural Science and Health Education Grade 4-7 and Agricultural Science Grade 8-10.

Table 5: Teachers' current position, qualifications and subjects they are teaching

	Categories	Teachers' code	Frequency
Teachers' current position	Teacher (Teacher F	T ₁ Q ₁ F, T ₂ Q ₂ M, T ₃ Q ₃ F, T ₄ Q ₄ F, T ₅ Q ₅ M, T ₆ Q ₆ M, T ₇ Q ₇ M, T ₈ Q ₈ M, T ₉ Q ₉ M, T ₁₀ Q ₁₀ M, T ₁₁ Q ₁₁ M, T ₁₂ Q ₁₂ F, T ₁₃ Q ₁₃ F, T ₁₅ Q ₁₅ F, T ₁₆ Q ₁₆ M, T ₁₇ Q ₁₇ M, T ₁₈ Q ₁₈ M, T ₁₉ Q ₁₉ M, T ₂₀ Q ₂₀ F, T ₂₂ Q ₂₂ M, T ₂₃ Q ₂₃ M, T ₂₅ Q ₂₅ F	22
	HOD	None	0
	Principal	T ₂₄ Q ₂₄ M	1
	Education officers	T ₁₄ Q ₁₄ M, T ₂₁ Q ₂₁ F	2
Qualifications	BETD	T ₃ Q ₃ F, T ₇ Q ₇ M, T ₈ Q ₈ M, T ₂₀ Q ₂₀ F, T ₂₂ Q ₂₂ M, T ₂₄ Q ₂₄ M	6
	Diploma in Ed.	T ₂₂ Q ₂₂ M, T ₂₄ Q ₂₄ M	2
	Adv. Dipl. In Ed.	T ₂ Q ₂ M, T ₃ Q ₃ F, T ₅ Q ₅ M, T ₁₃ Q ₁₃ F, T ₁₅ Q ₁₅ F, T ₁₈ Q ₁₈ M, T ₁₉ Q ₁₉ M T ₂₀ Q ₂₀ F, T ₂₅ Q ₂₅ F	9
	Diploma In Ed. + ACE	T ₁ Q ₁ F, T ₄ Q ₄ F, T ₆ Q ₆ M, T ₈ Q ₈ M, T ₉ Q ₉ M, T ₁₀ Q ₁₀ M, T ₁₁ Q ₁₁ M, T ₁₂ Q ₁₂ F, T ₁₆ Q ₁₆ M, T ₁₇ Q ₁₇ M, T ₂₃ Q ₂₃ M, T ₁₆ Q ₁₆ M	12

	Bachelor Degree in Ed	T ₁₄ Q ₁₄ M	
Science subjects they are teaching	Physical Science grade 8-12	T ₂ Q ₂ M, T ₅ Q ₅ M, T ₇ Q ₇ M, T ₈ Q ₈ M, T ₉ Q ₉ M, T ₁₀ Q ₁₀ M, T ₁₁ Q ₁₁ M, T ₁₆ Q ₁₆ M, T ₂₀ Q ₂₀ F, T ₂₁ Q ₂₁ F, T ₂₄ Q ₂₄ M, T ₂₅ Q ₂₅ F	12
	Biology grade 11-12	T ₃ Q ₃ F, T ₁₄ Q ₁₄ M	3
	Life Science grade 8-10	T ₁ Q ₁ F, T ₃ Q ₃ F T ₄ Q ₄ F, T ₂₁ Q ₂₁ F	4
	Agriculture grade 8-12	T ₁ Q ₁ F, T ₃ Q ₃ F, T ₄ Q ₄ F, T ₁₂ Q ₁₂ F	4
	Natural Science & Health Education 5-7	T ₃ Q ₃ F, T ₄ Q ₄ F, T ₆ Q ₆ M, T ₁₃ Q ₁₃ F, T ₁₅ Q ₁₅ F T ₁₆ Q ₁₆ M, T ₁₇ Q ₁₇ M, T ₁₉ Q ₁₉ M, T ₂₃ Q ₂₃ M	9
	Other subjects (e.g. Mathematics)	T ₁₈ Q ₁₈ M, T ₂₂ Q ₂₂ M	2

4.2.1.5 Teachers' teaching experience

Table 6 below shows that teaching experience ranges from 4 years to 12 years. The majority of teachers (56%) have taught for 7 and 8 years. This is an indication that most teachers involved in this study are relatively experienced teachers.

Table 6: Total number of years of teachers' teaching experience

Number of years	Frequency	Teachers' codes
Less than 3 years	0	0
4 years	4	T ₁ Q ₁ F, T ₄ Q ₄ F, T ₆ Q ₆ M, T ₉ Q ₉ M
5 years	4	T ₅ Q ₅ M, T ₈ Q ₈ M, T ₁₃ Q ₁₃ F, T ₂₃ Q ₂₃ M
6 years	3	T ₇ Q ₇ M, T ₁₅ Q ₁₅ F, T ₁₆ Q ₁₆ M
7 years	5	T ₁₁ Q ₁₁ M, T ₁₂ Q ₁₂ F, T ₁₉ Q ₁₉ M, T ₂₂ Q ₂₂ M,
8 years	5	T ₂ Q ₂ M, T ₁₀ Q ₁₀ M, T ₁₈ Q ₁₈ M, T ₂₁ Q ₂₁ F T ₂₅ Q ₂₅ F
10 years	3	T ₃ Q ₃ F, T ₂₀ Q ₂₀ F, T ₂₄ Q ₂₄ M,
12 years	1	T ₁₇ Q ₁₇ M

More than 13 years	0	0
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4.3 Other quantitative data from the questionnaires

This section presents other quantitative data from the questionnaires (see Appendix 3A)

4.3.1 Teachers' existing beliefs towards Assessment for Learning strategies

Part B of the questionnaire aimed at finding out teachers' existing beliefs towards aspects of Assessment for Learning. Teachers were given a Likert scale with five options to choose the extent to which they agreed or disagreed. The options were as follows: Strongly Disagree, Disagree, Agree, Strongly Agree and lastly an option for those teachers who are not sure. The findings are presented in Table 7 below.

Table 7: Teachers responses towards general aspect Assessment for Learning

	N	Strongly Disagree	Disagree	Agree	Strongly Agree	Not sure
(a) Aspects of formative assessment strategy						
Teachers should elicit learners prior knowledge	25	0	2 (8%)	3 (12%)	20 (80%)	0
Teachers should explain learning goals/ basic competencies to learners	25	0	0	6 (24%)	19 (76%)	0
Teachers should ensure that all learners achieve basic competencies	25	0	0	10 (40%)	15 (60%)	0
Teachers should allow learners to take ownership of their own learning	25	0	1 (4%)	12 (48%)	12 (48%)	0
Teachers should allow learners to be involved in the planning of activities		2 (8%)	2 (8%)	16 (64%)	3 (12%)	2

	25					(8%)
Teachers should encourage learners to be actively involved in the lesson	25	0	0	4 (16%)	21 (84%)	0

As shown in Table 7, the data revealed that 6 (24%) agreed, 19 (76%) strongly agreed for teachers to explain the learning goals to learners. This is an indication that the teachers involved in this study recognised the need to inform learners about the learning goals as well as the basic competencies during their science lessons. This is done so that learners are aware of what is expected to be achieved by the end of the lesson. These findings are in line with the suggestion made by Gioka (2007) Linqanti (2014) Paulo (2014), who emphasised that learning goals need to be expressed so that learners can understand the goals they are pursuing and the quality of work they are aiming to achieve.

There was some disagreement, however, about whether teachers should allow opportunities for learners to be part of planning. The teachers' responses to allow learner involvement in planning revealed that 2(8%) strongly disagree, another 2(8%) also disagreed while 16(64%) and 3(12%) agreed and strongly agreed respectively. About 2(8%) were not sure whether learners should be involved in the planning of activities.

Teachers were further asked specifically about questioning and giving feedback as a strategy for assessment for learning. The data are presented in Table 8 below:

Table 8: Teachers' response to questioning strategy and giving feedback

	N	Strongly	Disagree	Agree	Strongly	Not sure
					Agree	
Questioning strategies						

Teachers should ask constructive and quality questions	25	0	0	0	25	0
					100%	
Teachers should allow wait-time before learners answer the questions	25	0	0	16	8	1
				(64%)	(32%)	(4%)
Teachers should allow learners to pose questions	25	0	0	9	16	0
				(36%)	(64%)	
Teachers should use assessment criteria to check learners' understanding	25	0	0	7	18	0
				(28%)	(72%)	
Feedback						
Teachers should give immediate feedback to learners	25	0	1	8	16	0
			(4%)	(32%)	(64%)	
Teachers should give individual feedback to learners	25	0	0	18	6	1
				(72%)	(24%)	(4%)
Teachers should give constructive feedback	25	0	0	7	18	0
				(28%)	(72%)	
Teachers should give time to learners to do correction based on feedback given	25	0	0	16	9	0
				(64%)	(36%)	

4.3.2 Discussion of teachers' existing beliefs toward Assessment for Learning strategies

Table 8 shows that teachers see the need to make use of formative assessment strategies during their lessons. For instance, 25 teachers (100%) in this study seem to support the notion that teachers should ask learners constructive and quality questions. This can either be setting quality or asking questions that enable learners to think critically. It is quite encouraging to note that all the teachers (25) strongly agreed that teachers should ask quality questions during their lessons. This finding is supported by Black et al. (2002), who are of the opinion that in order to bring change in classroom practice teachers need to move away from the routine of asking limited factual questions and refocus attention on the quality and the different functions

of classroom questions. This implies that teachers should not just ask any type of questions, but should rather ask constructive and thought-provoking questions.

Although teachers in this study believe that learners should be asked quality questions, it should be recognized that there are instances where the teacher lacks the pedagogical skills of the type of questions to ask in the class. In addition, Jones (2005) pointed out that questioning is something every teacher does naturally as part of their daily routine, but developing the skills associated with questioning techniques presents many challenges for teachers and is something that is developed over time. A study conducted in Turkey, suggests that “In order to ask questions that develop thinking skills, teachers should receive in-service training and attend workshops about questioning techniques” (Kucuktepe, 2010, p. 5195).

The result shown in Table 8 also revealed that the majority of teachers 16(64%) agreed, 8(32%) strongly agreed and 1(4%) were not sure that teachers should allow time before learners answer the questions. Teachers were further asked if they allow learners to ask questions or not and whether they use assessment criteria to assess learners’ understanding.

Teachers were asked to indicate if they support giving immediate feedback. The findings reveal that the majority of the teachers 16 (64%) strongly agreed, 8(32%) also agreed to give learners immediate feedback. Paulo (2014) alerts us to the importance of giving feedback so that students are able to build on their strength and work on their weaknesses. Teachers were asked their opinions on giving individual feedback. The number of teachers who support giving individual feedback was actually low as only 6 teachers (24%) strongly agreed. This seems to indicate that although teachers are willing to provide feedback at their convenience, they are not so positive as they did not strongly agree about giving individual feedback.

It could be argued that this highlights that teachers need to give learners constructive feedback and learners should be given ample time to use feedback given to improve their learning.

As noted above, it can be concluded that teachers’ existing beliefs and attitudes are positive towards the strategies of assessment for learning. I am hoping that what the teachers believe is what they actually do in the classroom in real practice.

Probing more on strategies of formative assessment, teachers were asked to list some examples of formative assessment. Teachers listed some examples of formative assessment strategies. The findings reveal that 23 (92%) believe that giving tests is top of the list of strategies for formative assessment. Another example that was mentioned is doing practical work. This is

followed by project, homework, assignment, presentation and classwork. However, only one teacher (4%) indicated the use of oral questions as a strategy, whereas the use of peer assessment and question and answer method were the least listed.

The results are shown in Figure 6 below:

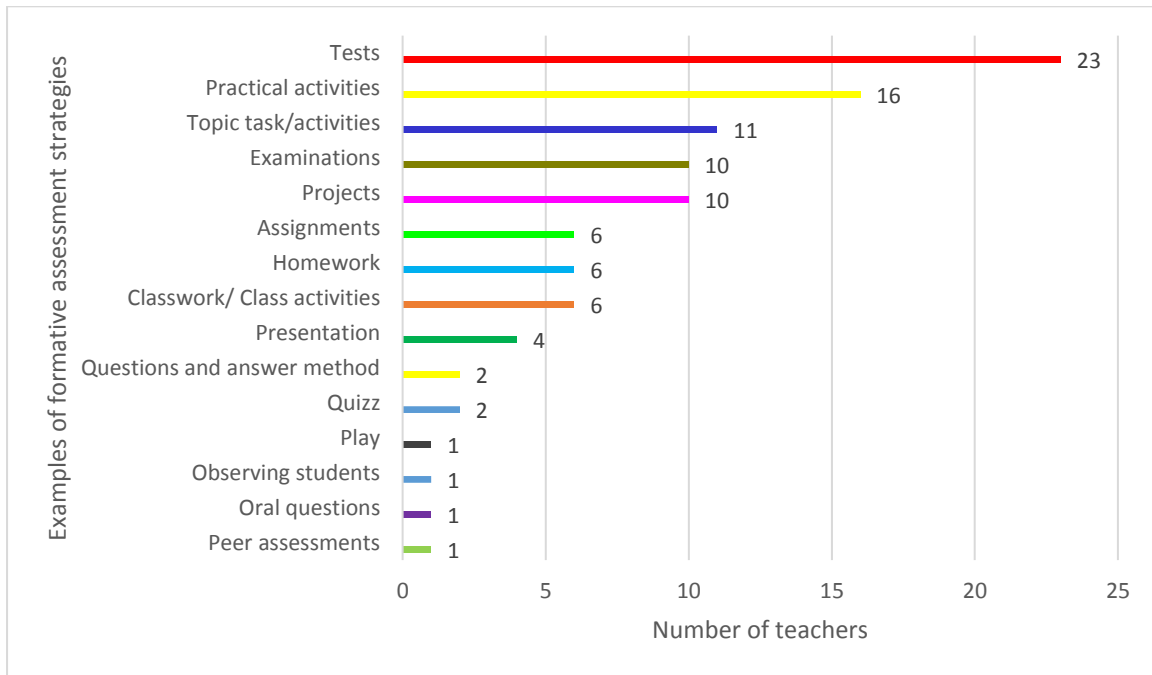


Figure 6: Perceived examples of formative assessment strategies

4.3.3 Teachers who received training on how to implement Assessment for Learning

The questionnaire further asked whether teachers received training on how to implement formative assessment. Figure 7 below shows the results:

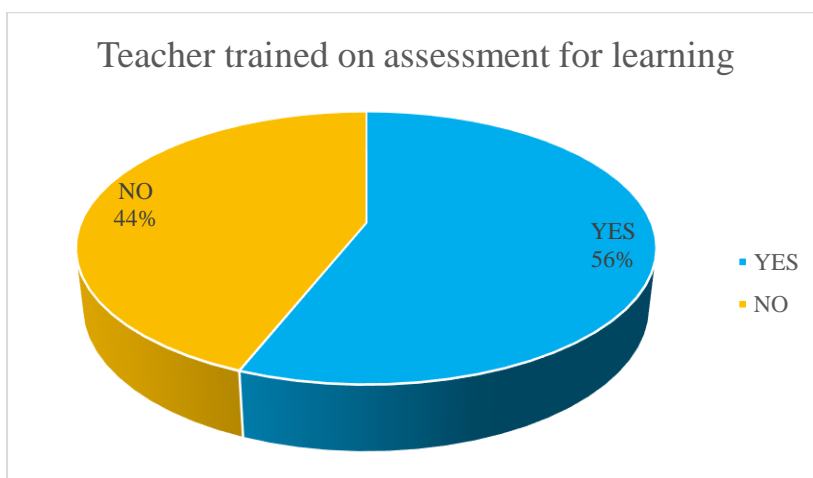


Figure 7: Teachers who received training on formative assessment

As can be seen from the figure 7, 14 (56%) teachers expressed that they received training on assessment for learning at college/university or through professional development programmes. Despite having received training, 11 out of 25 teachers (44%) claimed to have received training before. The question remains did they in fact received training. However, all 25 teachers (100%) showed their willingness to receive training again on how to improve their classroom skills when using Assessment for Learning.

4.4 Qualitative data from questionnaires

This section of the chapter discusses qualitative data in order to answer the research question on teachers' beliefs and conceptions towards Assessment for Learning (formative assessment). The data from the questionnaires were collated based on each question in the questionnaire. All 25 responses were colour coded. The data were then categorized based on similarities and sub-themes were generated. A table of preliminary sub-themes was generated.

Table 9: Preliminary sub-themes from the questionnaires

Teachers' code	Marked text	Research question	Sub-theme
T ₁ Q ₁ F, T ₄ Q ₄ F, T ₆ Q ₆ M, T ₁₀ Q ₁₀ M, T ₁₄ Q ₁₄ M, T ₁₉ Q ₁₉ M	Achieve master basic competencies/ to check learners understanding on a daily basis/ to inform learners about their progress/ assessing learners progress throughout the lesson/ to check overall progress of the learners for a specific grade/ help students to improve on their work	1	Perceived role of formative assessment on learners [Learners benefits)
T ₁₉ Q ₁₉ M, T ₂₀ Q ₂₀ F, T ₂₃ Q ₂₃ M, T ₂₅ Q ₂₅ F	Help teachers identify focus area/ control learning/ to check immediate understanding/ assessment in which the teacher allocate marks	1	Perceived role of formative assessment on teachers [Teachers benefit]
T ₂ Q ₂ M, T ₉ Q ₉ M,	Assessment serves as a mirror or a reflective substance/	1	Teachers' beliefs toward

T ₁₁ Q ₁₁ M, T ₁₉ Q ₁₉ M	Testing critical ability determine whether learning took place or not/ formative assessment has impact on learners progress as it lead to their summative assessment/ learners fail due to inadequate and poor quality formative assessment/ assessment differs from one teacher to another depending on the type of learners/ formative assessment makes learning easier		formative assessment
T ₁ Q ₁ F, T ₂ Q ₂ M, T ₃ Q ₃ F, T ₄ Q ₄ F, T ₆ Q ₆ M, T ₈ Q ₈ M, T ₁₅ Q ₁₅ F, T ₂₀ Q ₂₀ F	At each and every end of module/ give classwork during the lesson/ learners are given time to prepare before the date/ after I teach a topic I give them formative assessment/ I use formative after teaching the next day/ employ formative assessment after presenting every topic/ giving activities at the end of each topic or end of the term as well as at the end of the year/ give them examinations to write every end of term	1	Use of formative assessment during and after lesson
T ₁ Q ₁ F, T ₂ Q ₂ M, T ₅ Q ₅ M T ₆ Q ₆ M, T ₁₃ Q ₁₃ F, T ₁₈ Q ₁₈ M, T ₂₃ Q ₂₃ M	I use formative assessment in the form of tests, topic tasks, practical activities and quiz/ design class activity or homework/ teach a topic then give a test/ the following day using question and answer method/ asking questions in the classroom/ I use both play, task then finally test/pose oral questions	2	Suggested examples of formative assessment
T ₁₁ Q ₁₁ M, T ₁₆ Q ₁₆ M	Inadequate teachers knowledge concerning FA/ Lack of assessment strategies known by the teacher	3	Teachers' knowledge of assessment
T ₁ Q ₁ F, T ₅ Q ₅ M, T ₁₀ Q ₁₀ M	Organising questions/ lack of knowledge how to construct questions/ setting up quality assessment/ weighing questions/ arranging questions	3	Difficulty to set up quality questions
T ₁₉ Q ₁₉ M, T ₂₃ Q ₂₃ M	Lack of interest in doing their work, learners shy to respond to oral questions	3	Learners attitude
T ₄ Q ₄ F, T ₁₃ Q ₁₃ F, T ₂₂ Q ₂₂ M	Number of learners/ Overcrowded classroom/ Too many learners to give individual feedback	3	Influence of overcrowding

T ₁₂ Q ₁₂ F, T ₂₅ Q ₂₅ F, T ₁₀ Q ₁₀ M, T ₁₁ Q ₁₁ M	Tasks given should reflect exam condition/ award marks that correspond to their understanding/ learners familiar with how questions are asked and how to tackle them/ learners better understanding of what is expected in their final exam	3	Exam oriented culture
T ₂ Q ₂ M, T ₃ Q ₃ F	Time allocated for each lesson, time to set up task	3	Time constrain
T ₁ Q ₁ F, T ₃ Q ₃ F, T ₁₀ Q ₁₀ M, T ₂₁ Q ₂₁ F	Opportunity to improve skills/ Well informed teachers and received proper training/ need to be coached on question formulation/ training needed to assess, evaluate and analyse assessment results	3	Train teachers on assessment strategies
T ₅ Q ₅ M, T ₁₀ Q ₁₀ M, T ₁₈ Q ₁₈ M, T ₂₄ Q ₂₄ M	Workshop to be able to set quality assessment/ Workshop on how to assess/ provide samples of assessment/Workshop on doing assessment	3	Workshop on doing assessment
T ₁ Q ₁ F, T ₂₄ Q ₂₄ M	Share ideas on how to do formative assessment/ organising subject meetings with other colleagues / Group designing task/ Group designing of marking criteria,	3	Working together
T ₁₃ Q ₁₃ F	Teachers commitment/ using more than one teaching method	3	Teachers commitment
T ₁ Q ₁ F	Assessment to be incorporated at university or college	3	Incorporation in University/ college curriculum
T ₅ Q ₅ M, T ₁₉ Q ₁₉ M,	Make learners feel part of the group/ build learners confidence to try new knowledge/ improve learners willingness to learn/ motivate learners	3	Learners motivations

The emerging sub-themes were further combined based on their similarity. Three themes emerged and they are summarised below.

- Theme 1: Teachers' views and conceptions about Assessment for Learning
- Theme 2: Teachers' current practice of formative Assessment for Learning

- Theme 3: Perceived factors that enable or constrain implementation of Assessment for Learning.

Table 10 below shows the themes presented together with the research question they are answering as well as the supporting literature/theory.

Table 10: Summary of themes and literature/theory

Themes	Research Question	Literature/Theory
<p>Theme 1: Teachers' views and conceptions about Assessment</p> <ul style="list-style-type: none"> ▪ Perceived role of formative assessment ▪ Teachers' beliefs and attitude toward assessment 	1	Ball (2000); Bell and Cowie (2001); Jones (2005); Willis (2009)
<p>Theme 2: Teachers' current practice of formative assessment</p> <ul style="list-style-type: none"> ▪ Teachers' use of Formative assessment strategies ▪ Examples of formative assessment strategies 	2	Black et al. (2004); Kandjeo-Marenga (2008); Thomas (2012); Yau (2004); Vandeyar and Killen (2007)
<p>Theme 3: Perceived factors that enable or constrain implementation of formative assessment</p> <p>Perceived constraints</p> <ul style="list-style-type: none"> ▪ Lack of teachers' knowledge ▪ Difficulty setting quality questions ▪ Learners attitude ▪ Exam oriented culture ▪ Class size ▪ Teachers workload and time ▪ Lack of learner motivation <p>Perceived enablers</p> <ul style="list-style-type: none"> ▪ Training and workshops ▪ Collaboration ▪ Incorporation in University curriculum ▪ Commitment and Motivation 	3	Jane (2012); Ndalichako (2015) Nyambe (2008); Kandjeo-Marenga (2008); Yau (2004)

4.5 Teachers' perceived views of formative assessment

This part presents teachers' views about the difference between formative and summative assessment. Teachers' perceived roles of formative are summarised in Table 11 below:

Table 11: Summarised teachers' perceived role of formative assessment

Question	Teachers' responses	Number of times responses mentioned	Teachers' codes
In your own views, what do you think is the purpose of formative assessment for learning?	To ensure learners acquire/master/achieve basic competencies	3	T ₁ Q ₁ F, T ₂₂ Q ₂₂ M, T ₂₄ Q ₂₄ M
	To assess learners' progress	6	T ₃ Q ₃ F, T ₅ Q ₅ M, T ₈ Q ₈ M, T ₁₀ Q ₁₀ M, T ₁₈ Q ₁₈ M, T ₂₁ Q ₂₁ F
	To check/test/ measure learners' understanding	2	T ₄ Q ₄ F, T ₇ Q ₇ M
	To check overall progress	1	T ₁₄ Q ₁₄ M
	To check immediate progress	1	T ₂₃ Q ₂₃ M
	To control learning	1	T ₂₀ Q ₂₀ F
	Help students improve on their work	1	T ₁₉ Q ₁₉ M
	To help teachers' identify areas of focus	1	T ₁₉ Q ₁₉ M
Is assessment in which teachers' allocate marks	1	T ₂₅ Q ₂₅ F	

The purpose of the question was to find out if participants could differentiate between formative and summative assessment. In analysing the teachers' responses on the role of formative assessment, it emerged that teachers understood the role of formative assessment in different ways. All the responses indicate that formative assessment is beneficial to the teacher and learners. Willis (2009) points out that assessment for learning informs both teachers and

students about the learning process and progress thereof. However, the teachers in this study seemed to hold different views on the purpose of formative assessment.

The teachers viewed Assessment for Learning as a strategy to see through and be able to alter the teaching methodologies when learners did not achieve the basic competencies. Assessment for Learning is viewed as enabling participants to review their own teaching practice. For example, T₁₂Q₁₂F stated that *“teachers can evaluate their teaching strategies and methodologies and make the necessary changes”*. Concurring, T₂₄Q₂₄M also pointed out that teachers need to alter their methodologies /strategies in order to meet the needs of the learners. If teachers alter their teaching strategies they believe it will enhance learners’ understanding. Bell and Cowie (2001) accentuate that the role of formative assessment can be viewed as the process by which teachers gather assessment information about the students’ learning with a view to promote further learning.

Similarly, the teachers in this study view Assessment for Learning as important because it is used to assess learners’ progress. For example, T₅Q₅F said, *“Teachers are able to find out their learners’ progress in terms of the content covered”*. T₁₀Q₁₀M and T₆Q₆M also mentioned similar views when they said that assessment for learning helps to inform learners about their progress and to see the learning progress throughout the lesson. The findings are aligned with findings by Jones (2005), who pointed out that Assessment for Learning is all about informing learners of their progress to empower them to take the necessary action to improve their performance.

Another perceived role of formative assessment that emerged, is checking learners’ understanding. The teachers also indicated that formative assessment is a strategy used by teachers to ensure that learners achieve the basic competencies or master all expected basic competencies. It is through formative assessment for learning that learners can feel part of the group. As they feel part and parcel of the group, it boosts their thirst for knowledge as teacher T₅Q₅M commented that it builds learners’ confidence to try new knowledge. Teachers believe this may lead to improvement as a result and lead to learners mastering the basic competencies.

However, there seems to be confusion between the role of formative and summative assessment. For instance, T₂₅Q₂₅F stated that formative assessment *“Is assessment in which teachers allocate marks”*. This is an indication that this teacher holds a different view about the role of formative assessment. Teachers tend to confuse the two types of assessment. It could

be argued that the teachers' views of assessment are not in line with the stipulated requirements of the Namibian National Curriculum, but rather they focus on allocating marks which is summative in nature. A study carried out by Harlen and James (1997) confirms that teachers tend to confuse summative and formative assessment. Teachers' understanding of the type of assessment has an impact on students' learning. Rashid and Jaidin (2014) thus caution that a very superficial understanding of assessment for learning may have serious implications for the ways in which it is implemented in schools.

Jane (2012) points out that the teachers' conceptions of assessment are affected by different factors such as overcrowding, compliance, time management, policy interpretation and implementation, extra administrative workload and paperwork, support from the departmental officials, training and resources.

4.5.1 How teachers use Assessment for Learning

The data in Table 12 below are categorized into two groups: firstly, to show teachers who use formative assessment during their lessons, and secondly, to indicate teachers who use formative assessment after teaching/lesson presentations.

Table 12: Summary of how teachers use formative assessment

Question	Teachers' responses	Number of times responses mentioned	Teachers' codes
	How teachers' use of formative assessment <u>during</u> the lesson:		
	Asking questions in the classroom, giving them tasks to do	1	T ₁₃ Q ₁₃ F
	Sometime I pose oral questions	1	T ₂₃ Q ₂₃ M
	How teachers' use formative assessment <u>after</u> the lesson:		
	I use formative assessment in the form of tests, homework, topic tasks, practical activities and quiz to the learners	6	T ₁ Q ₁ F, T ₂ Q ₂ M, T ₈ Q ₈ M, T ₁₂ Q ₁₂ F,

			T ₁₅ Q ₁₅ F, T ₂₄ Q ₂₄ M
	I employ formative assessment after presenting every topic. I give a series of homework, practical write up and finally a test	5	T ₈ Q ₈ M, T ₁₁ Q ₁₁ M, T ₁₇ Q ₁₇ M, T ₁₉ Q ₁₉ M, T ₂₃ Q ₂₃ M
	I teach a topic to my learners all of them at the same time then give them a test to check their understanding	1	T ₅ Q ₅ M
	After teaching the next day I have to use questions and answer method to check on their understanding	1	T ₆ Q ₆ M
	I give them examinations to write every term end as it is in the subject policy	1	T ₂₀ Q ₂₀ F
	I give learners exercises to do after I present my lessons so that they can complete immediately or at home	1	T ₂₃ Q ₂₃ M
	By giving tests and assignments that are done under supervision	1	T ₂₅ Q ₂₅ F
	I evaluate the performance of the learners and plan correctives for them	1	T ₂₁ Q ₂₁ F

In analysing teachers' responses, only 2 teachers (8%) indicated that they use formative during the lesson, whereas, 23 teachers (92%) indicated that they use formative assessment after teaching. As depicted by the data above, it is evident that teachers have a limited knowledge of formative assessment as most participants indicated that they use formative assessment after lesson presentation. Only two teachers (T₁₃Q₁₃F and T₂₃Q₂₃M) indicated that they employ formative assessment strategy during their lessons.

There seems to be a conflict between the guiding documents, teachers' beliefs and what they actually do in the classroom. The findings are similar to the observation made by Kuze and Shumba (2011) in their study conducted in South Africa, in which they noticed that teachers did the opposite of what they actually said formative assessment was. To support this, a study

carried out in Tanzania by Ndalichako (2015) also revealed that it is likely that there is a mismatch between what is being reported (teachers' beliefs about assessment) and what is actually practiced (implementation of the assessment).

In addition, there is no link between the perceived roles of formative assessment and how the teachers use formative assessment. Although in the previous question teachers were able to state the role of formative assessment, when asked to give details of how they use formative assessment in the classroom, however, the majority of them described what is regarded as summative assessment.

For instance, participant T₂₀Q₂₀F stated that, "*I give them examinations to write every term end as it is in the subject policy*". About six teachers (24%) stated that, they employ formative assessment after presenting every topic for instance by giving homework, practical write up and finally a test.

4.5.2 Teachers' perceived factors that constrain implementation of Assessment for Learning

The teachers in this study suggested a number of possible challenges they are faced with when using formative assessment. These include lack of knowledge on how to use formative assessment, class size, time constraints and difficulty when designing questions. These challenges are unpacked in detail below.

- **Teachers' lack of knowledge of assessment and lack of training**

The teachers said that one challenge of how to effectively use formative assessment is their lack of knowledge of how to design questions. For instance, T₂₄Q₂₄M highlighted that designing assessment tasks and designing assessment criteria can be a challenge. Echoing the same sentiments, T₁Q₁F, T₁₀Q₁₀M and T₅Q₅M also pointed out that some of the challenges are how to construct quality questions; arranging questions as well setting quality questions that enable learners to think critically and be engaged in the lesson.

- **Teachers' workload and class size**

The teachers also highlighted the issue of teacher-learner ratio in their science classrooms. T₁₃Q₁₃F mentioned that she has an over-crowded classroom, making it impossible to give the

necessary guidance to her learners. Some teachers highlighted that giving individual feedback can be difficult because there are too many learners in the class. However some teachers, for example T₆Q₆M, T₇Q₇M and T₁₂Q₁₂F, hold different views from others as they do not see any possible challenge. In contrast, T₁₄Q₁₄M indicated that, “*I have no idea whether there could be a challenge or not*”.

- **Time constraint**

The teachers also viewed time as one of the challenges in terms of planning and implementing assessment, as well as the duration of the lesson that can inhibit formative assessment from being fully implemented. These teachers alluded that time is not enough since the duration of the lesson is only 40 minutes. That is, time is very short and this makes it difficult to manage formative assessment. To this end, T₁₅Q₁₅F pointed out that,

“It is time consuming to do many practical investigations or experiments during the lesson instead of teaching about the content of the subject without practical activity”.

4.5.3 Teachers’ suggestions on how to overcome challenges when implementing Assessment for Learning

Teachers suggested a range of possible enablers such as workshops and training, integration of Assessment for Learning at university level, teacher-learner ratio as well as designing of assessment tasks together with those more experienced.

4.5.3.1 Training/workshops on Assessment for Learning

Teachers assumed that the training they received at colleges/university was not inclusive of Assessment for Learning. Hence, T₁Q₁F who suggested that Assessment for Learning should be incorporated at universities or colleges.

Apart from that, four teachers (16%) that is T₁Q₁F, T₅Q₅M, T₉Q₉M and T₂₄Q₂₄M pointed out that there is need for teachers to have workshops to deliberate on how to make use of Assessment for Learning strategies. These teachers highlighted that teachers need to be exposed to such workshops at the regional level. For instance, T₁₀Q₁₀F and T₅Q₅F respectively indicated that, “*Teachers should be given workshops on how to assess learners and how to set quality assessments*”. It is also evident from the teachers’ responses as stated by (T₁₆Q₁₆M and

T₁₈Q₁₈M) that there is need for teachers' training on how to implement assessment for learning in the teaching and learning process.

All these teachers (100%) acknowledged that they had obtained some form of training on formative assessment. However, they indicated the need to be exposed to workshops and training on how to assess learners. They called for possible training where they could be provided with examples of how to do assessment. Although the Namibian National Curriculum for Basic Education (2009) emphasises that assessment should be used to support learning rather than being examination driven. Despite that, how to go about using assessment to improve learning seems to be a challenge for teachers. Teachers' suggestion for training is recommended by Kandjeo-Marenga (2008), who emphasised that teachers need to be equipped with instructional skills that will enable their students to acquire higher order thinking and practical skills. Additionally, teachers need to be equipped with the pedagogical skills on how to use formative assessment as highlighted in the following teachers' excerpts:

“Yes, because sometime teachers assess but they do not evaluate and analyse assessment results. Training is needed to help teachers to assess, evaluate and analyse their assessment result in order to improve their teaching to ensure effective learning”
(T₂₁Q₂₁F).

“Yes, if teachers are well trained on how to assess their learners using formative assessment, they will improve their skills on how to effectively use it in their classroom”
(T₁₄Q₁₄M).

In this study, teachers showed their willingness to be trained on how to use formative assessment. T₄Q₄F acknowledges that some teachers do not have adequate knowledge concerning the type of formative assessment appropriate for each topic as well as the types of questions to ask.

As a regular practice in Namibia, teachers are trained during the implementation of new curriculum. Despite that, follow up in-service training and professional development training is not a common practice. Some teachers end up not even receiving training at all. Therefore, in a study carried out in South Africa, Jane (2012) recommends that there is a need for a systematic and continuous support to be given to teachers as they make attempts in integrating Assessment for Learning in their lessons.

4.5.3.2 Collaboration among teachers and relevant stakeholders

Another suggestion made by teachers is for teachers to work together. Teacher T₁Q₁F suggested that teachers who are knowledgeable need to share information with other colleagues. T₂₄Q₂₄M went further to suggest that teachers can form groups where they share ideas and can design practical tasks and designing assessment criteria together. The teachers suggested designing tasks groups. This initiative can be made possible whereby teachers at cluster, circuit, regional level come together to design quality tasks that will enhance learners' understanding. Some schools have more than one teacher for the same subject; these teachers can plan and design their activities together. However, teachers acknowledge that for effective designing of tasks and assessment criteria teachers need to be provided with examples of assessment tasks as suggested by T₁₈Q₁₈M.

As mentioned in the possible challenges, time emerged as one of the challenges. Teacher T₂Q₂M, T₃Q₃F, T₁₉Q₁₉M and T₂₁Q₂₁F all indicated that teachers can devote their afternoon time to do more work and assessing learners. The teachers also suggested a reduction in the teacher-learner ratio. These teachers feel that when there are too many learners in one class it will be difficult to give individual assistance.

For effective implementation of formative assessment there is a need to take into consideration the classroom size. From this study, teachers highlighted they have overcrowded classrooms. It then assumed that it will be quite challenging to give individual feedback to students when there are a lot of learners in the class.

Lastly, one enabling factor which was mentioned by the participants is for teachers to be committed to their work and also to motivate learners to be engaged during the lesson. Teachers highlighted that learners need to be motivated because some of them are shy to talk in the classroom and this will hinder the use of formative assessment strategy.

4.6 Concluding remarks

Based on the data that was gathered, and analysed from the questionnaires, it emerged that:

- Teachers hold different views and conceptions toward formative assessment. For instance, teachers tend not to differentiate between formative and summative assessment;
- Teachers' having different views affects the way they teach;

- Teachers highlighted the lack of training on how to implement formative assessment; and
- Teachers suggested sharing of ideas, collaboration and sharing of assessment criteria.

The next chapter focuses on how to engage with teachers and orientate them to the strategies of Assessment for Learning. Additionally, how to make use of assessment strategy during practical activities (Asheela, 2016) for students to gain deeper understanding.

CHAPTER 5: DATA PRESENTATION, ANALYSIS AND DISCUSSION (PHASE II)

5.1 Introduction

In the preceding chapter I presented, analysed and discussed data from questionnaires, which were based on establishing teachers' existing conceptions and experiences towards Assessment for Learning (AfL) or formative assessment. Notably, the data obtained from the questionnaires informed the planning and implementation of an intervention orientation workshop.

This chapter thus presents, analyses and discusses data from the intervention orientation workshop on Assessment for Learning or formative assessment implemented during practical activities using easily accessible materials. Essentially, the purpose of this chapter is two-fold (1) to present the facilitators' pedagogical strategies used during the orientation intervention workshop, (2) to present data from teachers' reflections after the intervention workshop in order to assess teachers' understanding and disposition towards assessment for learning (AfL) or formative assessment. The following research sub-question was addressed:

How does the intervention in the form of a workshop on Assessment for Learning (AfL) and practical activities influence science teachers' conceptions and dispositions towards the use of Assessment for Learning (AfL)?

5.2 Brief overview of the intervention orientation workshop on Assessment for Learning

The purpose of the intervention workshop was two-fold, (1) to realize the importance of using easily accessible materials, (2) to equip science teachers involved in the study with the necessary skills on how to use assessment for learning or formative assessment during practical activities. My research focus was on the latter. The workshop took place on five consecutive days at NIED-Okahandja.

During the workshop, a series of practical activities were planned and conducted with a total of 25 science teachers enrolled for a BEd (hons) degree. This group of science teachers was heterogeneous in that they teach a range of different science subjects (see Table 5). Due to the heterogeneity of participants and for the intervention workshop to meet the needs for all participants some of the practicals conducted were related to Physical Science and others to Life Science and Biology.

During the session, different practical activities were carried out. Firstly, the facilitator explained the aims and objectives of the session and tasked participants to get involved in groups. All in all, the session comprised of hands-on activities with an emphasis on predicting, explaining, observing, making conclusions, whole class discussions (arguments) and exchanging of ideas among participants. By the end of each practical activity participants were able to reflect on their predictions and to come up with some mind maps.

In addition, as part of the week's program, there was a 1 hour 30 minute session where students were introduced to concepts of assessment for learning (formative assessment). During the presentation on Assessment for Learning emphasis was put on how teachers should ask quality questions that enable participants to think for themselves. Another emphasis was on giving immediate feedback in order to inform the next decision to be made and ensuring that all the students understand. In addition to the presentation on assessment for learning, participants were also provided with some Compact Discs (CDs) with documents and videos on how to use Assessment for Learning strategies in the classroom.

5.3 Data from Observation

The focus of this section is to present what transpired during the intervention workshop and how the facilitator engaged with the participants. During all the practical activities, I had a dual role to play, that of a researcher and a participant observer as stated by Cohen, Manion & Morrison (2007). Observations were guided by a structured observation schedule. The observation schedule focused on (1) how practical activities are introduced to participants, (2) pedagogical strategies used by the facilitator (questioning and feedback), (3) Interaction between the participants and the facilitator as well as interaction of participants among themselves. Observations were supported by video recorded sessions.

5.3.1 The practical activities carried out by teachers

Selected practical activity 1:

Topic: Fermentation (Preparation of a local drink called *Oshikundu*)

The primary objectives of the practical activities were to ensure that participants are:

- able to use locally available materials to demonstrate scientific concepts in the syllabus; and
- equipped with skills on how to engage students by asking relevant, quality questions and providing participants with feedback in order to rectify their misconceptions.

- **Introduction of the task**

Firstly, the participants were welcomed to the session. The facilitator highlighted what was going to happen during the course of the week. Secondly, the participants were given an opportunity to reflect on the activity they were given (bottle ecosystem) during the January session to reinforce reflections skills. About four participants reflected on what happened with their activity. The facilitator then read through the pre-prepared worksheet together with the participants on what was going to happen.

As one of the strategies for Assessment for Learning (AfL) it is essential that participants/students are informed of what they are expected to learn. The assessment reform group (ARG) (1999) states that one of the characteristics of assessment that promotes learning involves sharing learning goals with students.

- **Questioning strategies**

Asking questions was one of the strategies predominantly used by the facilitator. The questions were presented in two ways, (1) questions in the worksheet were prepared ahead of time, (2) oral questions that were asked during the lessons.

The participants were provided with the procedures in the worksheets. As part of the worksheet students were expected to predict and explain their predictions before doing the practical activities. After doing the practical activity, participants were then expected to explore, observe and record their observations. Lastly, participants were expected to look at their predictions and compare whether they were correct or they needed to make the necessary corrections. A study conducted by Kibirige, Osondo and Mgiba (2014) revealed that the Predict → Observe → Explain (POE) approach was able to enhance learners' performance. As a result of using the POE strategy, learners were able to overcome their initial misconceptions and improved on their performance. Similarly, Maselwa and Ngcoza (2003) suggested the Predict Explain

Explore Observe Explain (PEEOE) approach to enhance learning during ‘hands-on’, ‘minds-on’ and ‘words-on’ practical activities.

Apart from the questions in the worksheets, it was observed during the session, the facilitator also asked a variety of questions orally. For example, when were they doing a practical activity on fermentation the participants from different cultural groups were asked how they prepare the local drink at their homes. She asked, “*Do you have something similar that you prepare in your culture*”? The purpose of the question was to engage participants’ prior knowledge as suggested by Stears, Malcolm and Kowlas (2003). The students answered the question based on what they do at their homes by highlighting that although they do not have having similar names they prepared something like that.

Some of the questions were probing questions to allow students to think for the answer themselves. Some of the questions were redirecting students to think for the answer. Instead of the facilitator providing the answer to the students, she would pose the question back to the participants resulting in them coming up with some correct answers. There were also questions that were asked to clarify things.

Likewise, participants also asked a variety of questions on what was not clear and concepts that required explanation.

- **Giving feedback**

The facilitator gave feedback to students. In some instances the facilitator did not immediately give feedback to participants but instead redirected the question to other students to give feedback. Thereafter, she consolidated the discussions and arguments. In instances where there were misconceptions, such misconceptions were cleared. Participants were given an opportunity to reflect and give the correct answer. Lastly, participants came up with the concept maps that emerged from the activity carried out. They presented their mind maps to the whole class.

- **Social interactions during practical activities**

It was observed that there was a high level of interaction between the facilitator and participants and also interaction within the groups. The class was arranged in such a way that students sat in groups of 5 or 6. In some of the groups participants shared the same local language and it was observed that in some instances they discussed in groups using their local language. Students were actively engaged as they assisted in doing most of the tasks, for example, in the preparation of *Oshikundu*, stirring, and filling and labelling of the containers. Students showed interest in the activity as they wanted to do most of the task themselves. This was evident as I was observing I had opportunity to move around the groups and one of the participants said “*If only other subject elective can be engaging as this type of activity makes me to always look forward to the science session*”.

- **Emerging mind maps**

The activity on fermentation was concluded with participants listing all the science concepts that emerged from the practical activity. The concepts that emerged made it easier for participants to realize that within one activity a lot of science concepts can emerge.

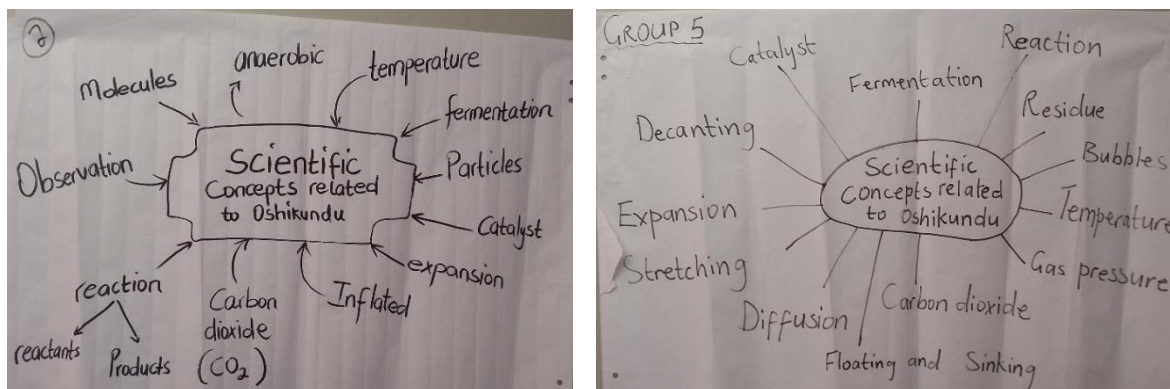


Figure 8: Emerging mind map from the experiment on fermentation

Selected practical activity 2:

Topic: Osmosis

- **Introduction of the task**

This practical task was mainly about introducing participants to teaching the topic of Osmosis and the aim of the task was explained to them. Thereafter, the participants were asked to predict and explain what would happen to both the eggs and the potatoes when they would be placed in different solutions. The experiment required about 8 hours for observation to be done. As a result, the participants had to wait for the next day to do the observations.

- **Questioning strategies**

With this activity, questioning was done the same way as in the previous task (See task 1)

After the observation was done, the participants had to compare these with their predictions. The participants then listed emerging concepts from the practical activity and thereafter they were asked to do mind maps (see Figure 9).

- **Examples of emerging mind maps from the eggs and potato experiment**

Example 1:

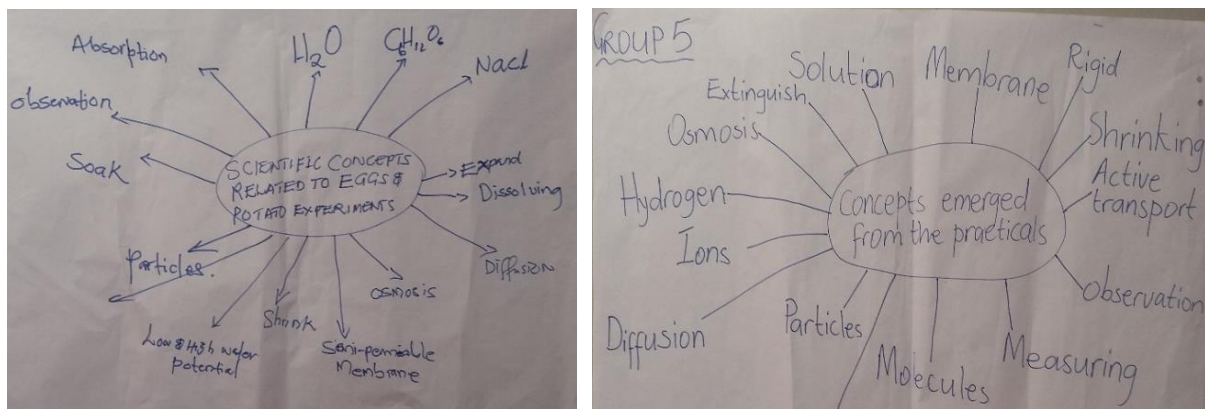


Figure 9: Emerging concept from the experiment on fermentation

Example 2:

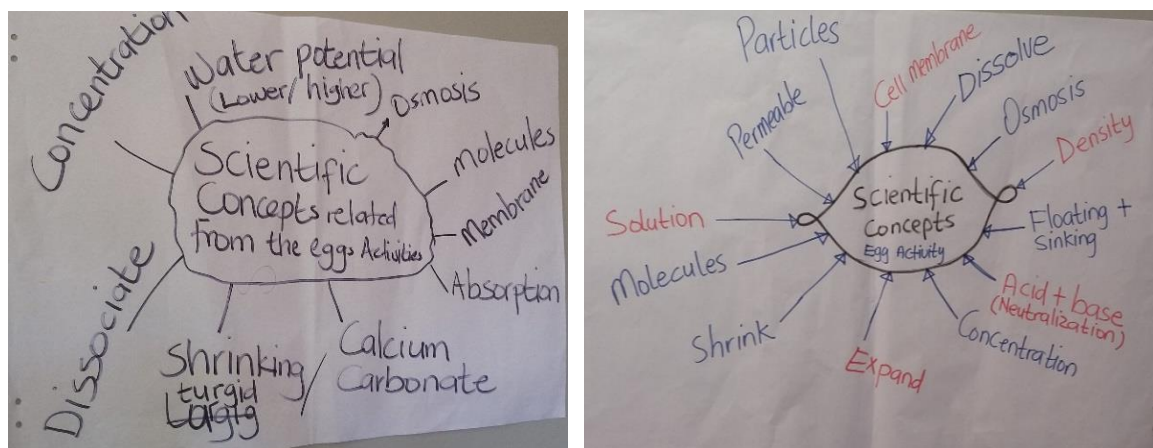


Figure 10: Mind map that emerged from the experiment of eggs

Selected practical activity 3:

Topic: Testing the presence of carbon dioxide (exhaled air)

- **Introduction of the practical task**

This practical activity was mainly to demonstrate the presence of carbon dioxide in exhaled air. At first participants had to predict and explain what would happen to the lime water before doing the experiment. Then participants used a drinking straw and blew exhaled air through the universal indicator and water solution prepared and observe the colour change.

Similarly, the questioning strategy was done as with all other practical activities. The facilitator asked a variety of questions, such probing questions, and redirected her questions so students could clarify their answers. Feedback was also given during this activity. Interaction among the participants was observed during the task. The activity was concluded with a whole class discussion, drawing conclusions and rectifying some of the incorrect predictions that had been made.

Black and William's (2002) study revealed a significant positive impact on students' performance when Assessment for Learning is done well. In the context of this study, during all practical activities carried out, the facilitator used a variety of teaching strategies to

demonstrate how to implement Assessment for Learning or formative assessment during practical activities as well as strategies that enhance students' learning.

The facilitator read through the handout to remind participants what was expected from them. Gioka (2007) emphasized that assessment criteria and learning goals need to be expressed so that students really understand the goals they are pursuing and the quality of work they are aiming towards. In addition, questioning was one of the strategies mostly used during the workshop. Notably also, was that the questions asked required participants' prior knowledge, probing questions, and questions that enabled students to think. There were also instances of questions that redirected participants to think of the answer. Sullivan (2003, p.2) acknowledges that

Questioning is the means by which teachers find out what pupils already know, identify gaps in knowledge and understanding and scaffold the development of their understanding to enable them to close the gap between what they currently know and the learning goals.

Likewise, the participants in this study were given immediate feedback and were given opportunity to look at their predictions and make the necessary corrections. Additionally, the facilitator clarified where there were misconceptions. Gioka (2007) emphasized that giving feedback involves making time to talk to students, and to teach them to be reflective about the quality of their responses and course work. The focus when giving feedback is not about giving marks, but using students' responses to give feedback.

5.4 Qualitative results from post intervention reflection

After the intervention workshop teachers were given an opportunity to reflect on what had happened, what they had learnt and what could have been improved if a similar intervention was to be carried out in the future. The purpose of the post-intervention questionnaire was to get some insights into teachers' beliefs after having been exposed to the training, teachers' understanding of assessment for learning or formative assessment as well as sharing their opinions and experiences of the intervention workshop.

In the post questionnaire, the participants were asked the following questions:

- This week we carried out some practical activities using easily accessible materials. We also had a workshop on assessment for learning. Do you have any past experiences in this during your schooling/ tertiary studies/teaching experiences?
- What are your feelings regarding the approach we used this week of Predict → Explain → Explore (practical activity) → Observe → Explain (PEEOE) approach?
- What are your thoughts toward the use of formative assessment?
- Has your participation in this workshop changed your attitudes toward implementing of formative assessment during practical activities and if so in which way? Explain.
- Would you recommend the workshop to be carried out to other science teachers in Namibia? Give reasons
- Lastly, participants were asked to present additional comments.

The data from the reflections were collated and analysed. From the teachers' responses, data were grouped into categories based on similarities and differences. The data from the post questionnaire are presented based on the following analytical categories as emerging from the data: Teachers' past experience of the workshop on practical work and on assessment for learning; teachers' views regarding the PEEOE approach used during the intervention (Maselwa & Ngozo, 2003); teachers' views and attitudes toward the use of assessment for learning; teachers' understanding of formative assessment. Data from these reflections are presented and discussed below.

5.4.1 Teachers' past experiences on workshop assessment for learning as well as using easily accessible materials

Teachers were asked if they had been exposed to a similar intervention before. Some of the participants reflected that they did not have past experiences of a similar workshop during tertiary education or during their teaching experience. Participants acknowledged that the workshop was helpful and they indicated to have learnt much. For example, the participants reflected that:

No past experience and I have learned a lot from this workshop (TR2)

No, I never had experience on these kind of activities in fact it was really a good learning experience (TR13)

There were a few participants who indicated that they have past experience during their tertiary studies, but went on to indicate that only to a certain extent as put forth by participant TR19 who described the past experience as more ‘laboratory based’. From my point of view, this may imply that the teachers mostly just demonstrate without engaging the students. The students are not given opportunity to predict, explain and then do the observations. Another participant acknowledged that he/she had been exposed before but admitted that it was just a little bit. In addition, participant TR20 admitted to have experience, but that it was not similar to what was done during this week as the part of assessment was fascinating.

5.4.2 Teachers’ opinion towards the use of PEEOE approach

Different codes were used to label the participants reflections. For example, T represents teachers and R represents reflection. For example, TR1 is teacher number 1 and TR3 is teacher reflection 3 and so on.

Table 13: Summarized teachers’ views regard the PEEOE approach used during the intervention workshop

Categories	Teachers’ responses	Teachers’ code
The type of approach	fantastic approach/good idea /good approach/ great approach	TR1, TR3 TR4, TR11
Learners’ engagement	Helps learners to be engaged fully in the lesson/ encourages engagement	TR4, TR20
Enable learners to think critically	Promoting thinking and enhance learning/ the predictions allows learners to think critically to what will happen/ it probes critical thinking in learners/ allows learners’ to think	TR2, TR6, TR9, TR11
Encouraging use of prior knowledge	Encourage teachers to make use of learner’s pre-knowledge/ it broadens the understanding of the learners by exploring more/ see if their prediction were correct/ help students to move from what they know (based on their experiences)	TR10, TR12, TR23
Confirm facts	Allows learners to think and then later to confirm their assumption/ serve as technique to confirm their prediction.	TR11, TR19

Rectify mistakes	Learners will be able to correct themselves after the practical activity has been conducted/ later see how far or close our predictions were to the observation.	TR12, TR18
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In analysing participants' responses, it can be inferred that the participants in this study regarded the PEEOE approach (Maselwa & Ngcoza, 2003) as a good and meaningful approach. The strategy is viewed as a good one because it enables participants to be engaged fully. Participants believe that the strategy promotes critical thinking. For example, TR6 stated that *"the predictions allow learners to think critically about what will happen."* In addition, the participants also believed that the approach encouraged learners to make use of their prior knowledge as proposed by Roschelle (1995). Using these strategies will enable students to understand concepts from what they already know and build on the new knowledge. Furthermore, the participants also indicated that the approach gives opportunity to students to compare and rectify their predictions.

5.4.3 Teachers' attitudes towards formative assessment after the intervention workshop

In question 4 of the post-questionnaire, teachers were asked to give their thoughts regarding the use of formative assessment. Two categories emerged from the data, (1) teachers' understanding of formative assessment and (2) teachers' views toward the use of formative assessment.

Table 14: Teachers' attitudes after the intervention

Categories	Marked text	Teachers' code
Relevancy in the learning process	It is important in the learning process	TR22
Assessing throughout the lesson	As teachers we should assess throughout the lesson/ we should not wait until we are done with our topic but we can assess our learners during the lessons/ I feel they should be done throughout the lesson through questioning, feedback	TR3, TR8, TR13
Giving immediate feedback	Give feedback on time and give learners chances to do a self-assessment.	TR6
Teachers' use of formative assessment	This is a very crucial aspect that teachers do not do in the classroom where they are doing it, it is not effectively done, this need to be taken a step further so that teacher understand what formative assessment is.	TR20

Based on the data as shown in Table 14, participants hold positive views towards formative assessment compared to the pre questionnaire data. For example, data in Chapter 4 reveals that the participating teachers regarded formative assessment mostly to be used at the end of the lesson or after lesson presentation (see Section 4.5.2). However, it is quite encouraging to note that participants (TR3; TR8; TR13) highlighted that formative assessment should be done throughout the lesson. This is an indication of change of disposition among the participants.

The participants indicated the need to give immediate feedback during science lessons. That is, teachers should not wait for too long or the next day to give feedback. For example, TR6 indicated that teachers should give feedback on time and learners should also be given an opportunity to do self-assessment. This implies that after learners are given feedback opportunity should be given for learners to reflect on the feedback given.

TR20 and TR22 are of the opinion that the way formative assessment is implemented is not effectively done. Echoing the same sentiments, participant TR14 even stated that “*formative assessment is something I heard of but I didn't really implement it in the classroom*”. This

implies that what teachers regard as formative assessment strategies is totally different from what is stipulated in the curriculum and literature.

As noted above, there is a positive change in teachers' attitudes. In Chapter 4, teachers thought that formative assessment was used for promotion purposes only. To this end, TR12 narrated that, "*I thought it was meant for promotional purpose only*". This type of change in attitude is essential to enable teachers to assess themselves and shift away from seeing assessment for examination purposes.

5.4.4 Teachers' understanding of formative assessment after the workshop

Table 15: Shows teachers' understanding of formative assessment after the workshop

Categories	Teachers' understanding of formative assessment?	Teachers' code
Learners' understanding	It reveals the extent to which learning takes place / keeps track of how learning is taking place/ It is a good way of assessing learner's progress/ helps a teacher to find out whether learning has taken place/ help teachers to measure students understanding immediately	TR1, TR5, TR21, TR14
Change teaching approach	It helps the teacher to measure, evaluate the learning process in terms of weaknesses and strengths/ allows the teacher to quickly change his/her approach of teaching a particular topic/ To keep track of their strength and weaknesses	TR4, TR9, TR21
Improve teaching	It can also help us to improve/ teacher will be able to improve teaching and help learners know where they need to make change.	TR5, TR7
Master content	Good tool of determining if learners have mastered what they have learned/Helps learners to master the content very well which will be useful in their final assessment (examination).	TR11, TR16

Unlike teachers' understanding of formative assessment as presented in Chapter 4 (see Section 4.5) where teachers were confused between formative and summative assessments analysis of teachers' response to this question, shows that teachers who explained formative assessment

did not confuse formative and summative assessments. Participants indicated that formative assessment benefits both the teacher and the students. Benefits for teachers are that; it is a tool to identify strengths and weaknesses. It is also a tool to measure students' progress.

Equally important, formative assessment is beneficial to learners as it improves their performance by engaging students, by asking quality questions as well as getting feedback. Participants also believe that once the teacher becomes familiar with the use of formative assessment it leads to improvement in final results. For example, participant TR16 states that “*formative assessment helps learners to master the content very well which will be useful in their final assessment (examination)*”. This implies that teachers' focus should not only be on summative assessment but focus should be on the process of learning (formative assessment) which results in summative assessment.

5.4.5 Comments and suggestions on the intervention workshop

Lastly, participants were given an opportunity to give further comments. The comments are summarized in Table 16 below.

Table 16: Shows teachers' comments and suggestions about the workshop

Participants' additional comments:

- ore time needed to revise some of the practical activities (TR3)
- I would like to emphasise that teachers need to change their attitude towards practical activities and assessment this is important as it ensure effective learning (TR4)
- It was an interesting week and I have learnt a lot which I will definitely do with my learners (TR7)
- Do more practical activities during the next session for us to gain skills and apply them at school (TR9)
- XX and your team you are asset in my BEd hons course (TR12)
- I have learnt a lot from her (TR14)
- Yes, thanks for entitling us to instilling a positive attitude towards the use of practical activities using easily –accessible materials (TR15)
- Teachers should be helped to changes their attitude toward practical activities and not excuses of unavailability of resources and time constrains (TR18)
- I learnt a lot from you. Keep it up!! (TR22)
- I have enjoyed the science practicals for this session and really learnt a lot (TR23)

5.5 My reflections on the intervention workshop

In my view, this intervention played a great role in the professional development of teachers since teachers are faced with the dual task of teaching as well as using different strategies to ensure that learning has taken place. The intervention is a gateway in providing teachers with the necessary skills so that effective teaching and learning can take place. This intervention workshop equipped teachers with the necessary skills on how to use Assessment of Learning during practical activities using easily accessible materials. As observed, teachers were actively engaged as they did most of the tasks during these workshops. I also observed that there was positive attitude among teachers toward the use of Assessment for Learning as they were willing to be observed as they implemented this with their learners.

5.6 Concluding remarks

This section summarised what took place during the intervention workshop and teachers' responses to the questionnaire. The following conclusion can be made:

- There is a change of views and attitudes among the teachers. Teachers view formative assessment as important and the type of assessment that should be used throughout the lesson and not at the end of the lesson;
- Teachers regard formative assessment as crucial as it helps both the teachers' and learners. For learners if formative assessment is done well, they can master the content very well and this will lead to good performance; and
- Teachers were positive with the workshop as it enhanced their professional development, hence there was a call for other science teachers to be exposed to similar interventions.

The next chapter presents data from two teachers who implemented Assessment for Learning (formative assessment) during practical activities in their science classrooms.

CHAPTER 6: IMPLEMENTATION OF ASSESSMENT FOR LEARNING STRATEGIES: CLASSROOM PRACTICE

6.1 Introduction

In the previous chapter I presented, analysed and discussed the data from the intervention-orientation workshop. The purpose of the intervention was to demonstrate to participant teachers how to implement assessment for learning or formative assessment strategies during practical activities using easily accessible resources.

The main purpose of this chapter is to present, analyse and discuss data generated from the lesson observations. I observed two Life Science teachers as they implemented strategies of assessment for learning or formative assessment during practical activities. I also did post lesson reflective interviews with the two teachers. The following sub-question was addressed:

What factors enable and/or constrain science teachers' conceptions and dispositions towards the implementation of Assessment for Learning (AfL) during their science practical lessons?

6.2 Teachers' profile

Table 17 below indicates the information of the teachers who took part in Phase III of the study.

Table 17: Demographic information of participants

Categories	Teacher A	Teacher B
Name of teacher	Rumbidzai (pseudonym)	Delizia (pseudonym)
Name of region	Omusati region	Omusati region
Name of school	Rudo JS (pseudonym)	Rufaro JS (pseudonym)
Phase at school	Grade 1-10	Grade 8-10
School type	Public	Public
Residence type of learners	Day	Day

Total number of teachers' at school	11	11
Number of science teachers	Three teachers'	Two teachers'
Number of grade 10 learners	25	27
Years of experience	5	9
Highest qualification	1) Basic Education Teachers' Diploma (BETD), 2) Advance Certificate in Education	1) Basic Education Teachers' Diploma (BETD), 2) Advance Certificate in Education , 3) Professional Diploma in Education
Subjects currently teaching in (2016)	Life Science grade 8-10 Agriculture grade 8-10 Elementary Agriculture Grade 7	Life science grade 8-10 and Agriculture grade 8
Degree currently studying	Postgraduate Bachelor of Education degree Honours	Postgraduate Bachelor of Education degree Honours

The table above shows the information of participant teachers who took part in Phase III of the study. The data revealed that both teachers are qualified and they both hold a Basic Education Teacher Diploma (BETD). In addition to the first degree they also hold Advanced Diplomas and Advanced Certificate in Education (ACE). During the time of this study, both teachers were enrolled for the Bachelor of Education degree (Honours) and were in their second year. They are both experienced teachers as they have taught for more than six years. For confidentiality purposes, participants were asked to suggest pseudonyms for themselves.

In addition to their teaching responsibilities, both teachers have responsibilities to carry out at their respective schools. For example, Delizia is a member of school board, a circuit facilitator

for Life Science grade 8-10 and a subject head for Science subjects. On the other hand, Rumbidzai is a subject head, member of school management as well as a national marker for the previous years.

6.3 Data from Classroom Observations

Observation was one of the main strategies used to collect data in this study. A series of practically-based activities lessons were observed. The primary purpose to use observation was to get a sense on how these selected teachers implemented assessment for learning or formative assessment strategies. The focus of the observation was to look at the learning goal (basic competencies) during practical lessons, the nature of questions that these teachers asked, the nature of feedback given during the practical lessons, the wait time and other pedagogical strategies used by teachers during the lesson. During observation I was guided by the observation schedule.

The practical activities carried out are discussed below.

6.3.1 Description of practical activity 1

Note: [The first practical for both participants was similar, thus, the description will be integrated together].

Topic: Fermentation [Preparing of a traditional drink called *Oshikundu*]

This practical activity was carried out by both teachers. The primary purpose of the practical activity was to engage learners, and use a variety of assessment for learning strategies to enhance learning. The practical lesson began with both the teachers asking learners' background knowledge about *Oshikundu*. Rumbidzai started the activity by asking learners: "*Is there anyone in the class who does not know Oshikundu?*" While Delizia engaged with the learners by asking learners to brainstorm the materials that are needed for making the traditional drink. Before starting with the experiment the teachers also dwelt on different ways of preparing as learners are not from the same *Ovambo* tribe. Both teachers assisted learners by providing information on what the practical activity is all about. Both teachers highlighted

the basic competencies for the practical activity. In addition, the teachers prepared the worksheet before the session which was also guiding learners during the activity.

The worksheet consisted of the procedure to follow accompanied by questions requiring learners to **predict** and give **explanation** for the prediction (PE) and also carry out **observation** and give **explanation**. The worksheet was guided by the PEEOE approach. Before doing the experiment, learners wrote down their predictions and provided explanation for their predictions. It was observed that from both schools some of the predictions were correct and others were not correct. After learners made predictions, learners had to leave the practical and wait for the next day to do the observation. Figure 11 below illustrates the experiment after it was set up. Learners had to wait for some hours before the observation.

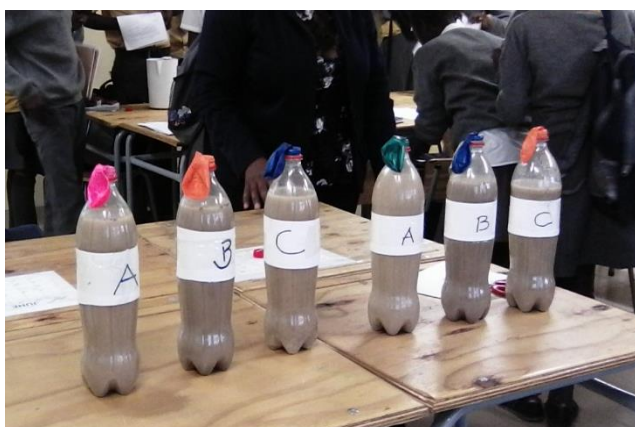


Figure 11: Container of Oshikundu experiment at Rufaro JS

The practical activity required two days to allow fermentation to take place. Learners had to do the observation the next day. During day 2 learners started with the observation of what had taken place in each container and then wrote down their observation. It was evident that some of the learners' predictions were not in line with the outcome from the experiment. As a result, both teachers asked the learners with wrong predictions to rectify the error and write the correct answer after observation is made. Learners assisted each other to realise where they made the mistake with their predictions. Learners also discussed what happened in each container.



Experiment at Rudo JS



Experiment at Rufaro JS

Figure 12: Oshikundu experiment results from both schools

Furthermore, day 2 of the practical activity ended with learners brainstorming the concepts that emerged from the practical activity and learners came up with mind-maps.

The next section presents a description of practical activity two.

6.3.2 Description of practical activity 2

Topic: Preparation of an animal cell

The practical activity started with both Rumbidzai and Delizia stating the purpose of the practical lesson. They also highlighted the materials needed for this experiment. The practical activity involved placing the eggs in the vinegar to remove the hard shell. After the egg shell is removed the same eggs will be used to demonstrate the process of Osmosis. The eggs were placed in different solutions such as vinegar, water, Coca Cola and lemon juice. Both teachers asked learners to place three eggs in a container with vinegar and label them V1, V2 and V3 respectively. Then the other eggs were placed in lemon juice, pure water and Coca Cola. The experiment was set up. Learners had to make their predictions and give explanations for their predictions. The experiment was left overnight for any possible changes to take place.



Figure 13: Samples of the eggs experiment

On day 2, of the observation teachers asked learners to collect the containers with the eggs and observe the change that took place. Learners removed the eggs and measured them. At school B, Rufaro JS, learners used a string to measure the eggs. Learners from both schools observed the change that took place and wrote down their observation in a worksheet.

Learners noted the changes that had taken place in the container. For example, learners observed that there was foam on top of the container containing eggs and vinegar. The teacher asked learners to discuss their observation with others in their groups. Learners discussed in their groups. The teacher highlighted that this is another way to prepare an animal cell. The teachers moved around to check learners' observation. In addition, the teachers guided the whole class in discussion on what had brought about the changes that were observed. Discussion on the change in size of the egg took place. Learners assisted each other in groups to give reasons for their predictions. The practical activity ended with learners listing concepts that emerged from the practical activity.

6.3.3 Description of practical activity 3

Topic: Investigate the effect of solutions on plant cells and animal cells

Both teachers did the practical activity to investigate the effects of placing a plant cell and animal cells in different solutions. Rumbidzai started the practical activity by giving instructions to learners on what to do. She went further to explain the background of the task. Delizia reminded learners about what they did at the beginning of the year on the topic of Osmosis. One of the learners at Rufaro Junior Secondary school defined Osmosis as the movement of water molecules from a region of high concentration to a region of lower

concentration. Delizia emphasised that learners should not define Osmosis in terms of concentration but rather they should define it in term of water potential. Delizia explained that:

“You know if you don’t want to lose marks during exam you should define Osmosis as the movement of water molecules from a region of higher water potential to a region of low water potential through a semi- permeable membrane”.

Rumbidzai asked learners to cut the potatoes into cubes whereas Delizia asked learners to cut them into cylinders. After the stage of peeling and cutting the potatoes learners were required to measure them and record the measurements of the potatoes in their worksheets. Thereafter learners had to immerse the potatoes in different solutions such as 1) pure water, 2) concentrated salt solution and 3) diluted solutions. Learners from both schools had to label the containers and the teacher at Rudo JS asked the learners about the importance of labelling containers.

During the practical activity set up, Delizia asked learners to distinguish between concentrated salt solution and diluted solution. Learners discussed this in groups and shared their ideas; although they seemed to understand the difference, some of the learners were failing to express themselves. Delizia went to the extent of illustrating on the chalkboard by drawing molecules on the difference between concentrated solutions and dilute solutions. Delizia asked learners to think of how they make tea at home. She stated that when you are making tea, to one cup you add one teaspoon of sugar while the other cup you add four teaspoon of sugar. She then asked learners which one is more concentrated? So, learners at Rufaro were able to state that the cup where four teaspoons of sugar were added is the one which is most concentrated. Delizia then asked learners to link to what they are doing during the practical activity. Delizia highlighted the importance of diagrams in Life Science examination. She stated the diagram she used enabled the learners to understand the concept better. During the group discussion both teachers moved around learners groups to check learners’ progress as they discussed and made predictions. By the end of the practical activity session learners had to cut the potatoes into cubes and cylinder shapes. They measured the potatoes and prepared the different solutions and placed the potatoes in different solutions. The practical set up was then ready for Day 2.

Day 2 of the practical activity: both teachers asked learners to collect their containers and bring them to their group table. The following is what learners did. 1) Learners took out the potatoes and measured each potato from each solution. Learners used a string to measure the potatoes.

The teachers asked learners to write down their observations, discuss their observations in groups and give explanations for the change that had taken place. For example, Rumbidzai asked learners to think of what made the potato to change? Where was the high water potential? Teachers engaged learners to think of the scientific process that had taken place. At Rudo JS, one learner mentioned Osmosis, while at Rufaro JS one learner mentioned Diffusion. The teacher assisted learners to differentiate between Osmosis and Diffusion. At school Rudo JS the discussion went on further with learners defining the process of Osmosis and applying it in the context of the practical activity.

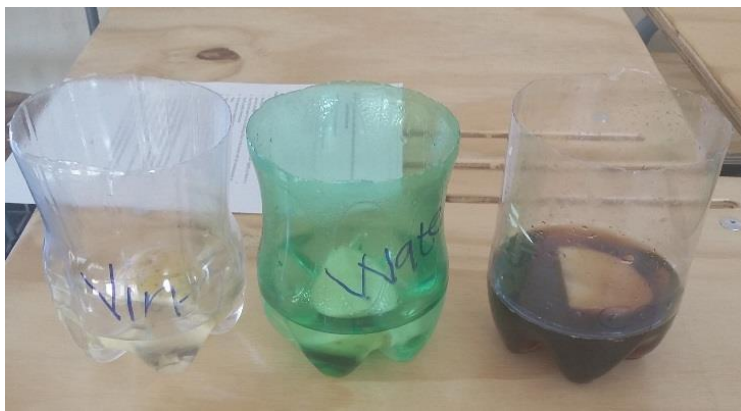


Figure 14: Sample of the potato experiment

The session ended with learners listing the key concepts that emerged from the practical activity from which they constructed some mind-maps.

In a nutshell, both teachers tried by all means to engage with the learners. They asked questions that enabled learners to think for themselves and derive the answers. Other questions were probing questions or they redirected the question to other learners so that they assisted each other with the answer. It was evident that the teacher used the scaffolding strategies during the practical activity.

In the next section, I present themes that emerged from classroom observation, videotaped lessons and post semi-structured interview.

6.4 Themes that emerged from Phase III, Observation and Post Interview

The data analysis process involved reading through the field notes taken during observations and reading post reflective interview several times in order to understand the data. In addition, the practical lessons were video recorded, the audio transcribed lesson was repeatedly read through and viewed several times. The interview transcript for the two teachers were also analysed to look for similarities and difference. Firstly, sub-themes emerged from the data and then common sub-themes were grouped together into major themes.

The following are the themes that emerged from observation and post reflective interviews: Teachers' views and disposition on the assessment for learning strategies, teachers' pedagogical strategy used during the implementation and factors that enable and constrain teachers' implementation of assessment for learning or formative assessment.

Table 18: The analytical framework showing the emerging sub-themes, analytical statement, research questions and data sources

Sub-themes	Analytical statements	Research sub-questions	Data sources
Teachers' views teachers' disposition towards assessment, Change in attitudes, PCK	Teachers' views, knowledge experiences and disposition toward the implementation of formative assessment during Science practical activities	1	Observation Post-reflective interview
Learners active engagement, Social interaction, language advantage and disadvantage of assessment for learning	Social interaction as a means for learners engagement	2	
Practical activity learning goal, the nature of questions, building on old knowledge, scaffolding strategies The nature of feedback, wait time, social interactions	Pedagogical strategies used by teachers during the implementation of formative assessment strategies	2	Observation Post-reflective interview

Collaboration, information sharing Ongoing teachers' support, Support by facilitator, Incorporate assessment in the university curriculum, Doing experiment beforehand	Factors that enable implementation of formative assessment during practical work	3	Observation Post-reflective interview
Learners' language, Insufficient time, Curriculum interpretation, Planning and designing of worksheet, SEOs' lack of knowledge on Formative assessment Exam oriented culture	Factors that constraint implementation of formative assessment	3	Observation Post-reflective interview

In order to answer my research sub-questions, the following analytical statements were developed:

- Analytical statement 1: Teachers' views, experiences and dispositions toward the implementation of formative assessment during practical activities
- Analytical statement 2: Teachers' pedagogical strategies (assessment for learning strategies) used during practical activities
- Analytical statement 3: Factors that enable and/or constraint teachers' implementation of formative assessment strategies.

Analytical statement 1: Teachers' views, experiences towards the implementation of formative assessment during practical activities

- **Teachers' understanding of Assessment for learning**

As mentioned in Chapter 2, teachers' understanding of assessment is essential to the teaching and learning. Vandeyar and Killen (2007) point out that teachers cannot use assessment strategies that they do not understand or for which they lack skills. Thus it is of great importance

to assess teachers' understanding of assessment for learning strategies. Apart from teachers' pedagogical strategies, teachers are expected to have knowledge of the subjects they teach.

During the post reflective interview teachers were asked to give an overview of what they understand by formative assessment. All participants were able to explain what is meant by formative assessments. For instance, teachers explained that formative assessment is the type of assessment that can be used during lesson presentation to improve learning. The following is what teachers referred to as formative assessment:

Well, the way I understand formative assessment now, I understand it as the type of assessment where learners' difficulties are diagnosed and learners are given feedback immediately in order to be at the same level with other" (Rumbidzai).

"Assessment has to do with planning well what to do in the class as well asking good question and giving feedback to learners and it has to do with peer and self-assessment. Also I understand it as a way learners are learning from each other's" (Delizia).

Teachers' understanding of assessment is in line with the definition of formative assessment. ARG (1999) offer a broad perspective of Assessment for Learning as assessment that deals with sharing learning goals, asking quality questions, giving immediate feedbacks and peer and self-assessment. It was vividly observed that the teachers used a variety of assessments for learning strategies during the implementation. This is an indication that they understand the key idea of Assessment for Learning. For instance, both teachers explained the learning goals to the learners, asked a variety of quality questions that enabled learners' to think, give immediate feedback based on learners' response and give opportunity for learners to learn from each other during practical activities.

Shulman (1986) stated that "Those who can, do. Those who understand, teach" (p. 14). This implies that the teachers are using Assessment for Learning strategies because they know and understand the benefits thereof. It can thus be concluded that the Intervention Orientation workshop had an impact on teachers understanding of Assessment for Learning strategies. Echoing the same sentiments, Shulman (1987) pointed out that teaching begins with a teacher's understanding of what is to be learned and how it is to be taught. During the practical activities both teachers tried to twin the subject content and using the pedagogies, which Shulman describe as Pedagogical Content knowledge. The purpose of the intervention workshop was

to enhance teachers' pedagogical strategies. The aim was to develop teachers' PCK in order to improve conducting of practical activities.

Ndalichako (2015) also drew attention to the expectation that teachers have to play a dual-role of facilitating students' learning and of implementing classroom assessment in a way that will enhance meaningful learning outcomes. This implies that teachers' understanding of subject content and understanding assessment is very crucial and only if they understand they will be able to use the methods in their teaching.

- **Teachers' views and experience towards the implementation of formative assessment during practical activities**

Formative assessment has been at the forefront of the teachers guiding documents such as the Namibian National curriculum for Basic Education of 2009. The Namibian curriculum emphasises that assessment should not be seen as a separate entity, but rather assessment should be seen as part of the everyday teaching and learning process. However, how teachers view and interpret assessment can impact the way they make use of it. Marshall and Drummond (2006) reinforce this view when they say that the beliefs teachers hold about learning impact on the way they apply assessment for learning in the classroom.

In the data collected, the two teachers' viewed the implementation of formative assessment as a good strategy to the teaching and learning of science. The teachers compared this to what they used to do in the past. For instance, one of the comments made in the interview Rumbidzai reiterated that: *"This is good because I wanted to see learners' engaging, actively participating in the lesson and as well learning from each other."* The teachers highlighted that the strategies enable learners to learn from each other, to think for themselves and to be actively involved. Delizia was positive that using the assessment for learning strategy was good and helpful as she stated that: *"I realised that learners have learnt, unlike in the past my learners just want to listening because the way they were asking questions was indicating that the questions were derived from what was said in the class."* Using assessment for learning strategies encouraged learners to take part in the lesson. These findings are similar to the findings by a group of researchers called ARG (1999) whose research indicates that improving learning through assessment depends on the active involvement of pupils in their own learning.

Teachers' views influence what they do in the classroom. Thomas (2012) states that teachers' beliefs affect their teachers' choices of assessment strategies. This idea is supported by Marshall and Drummond (2006) who remind readers that the beliefs teachers hold about learning impact on the way they apply AfL in the classroom. It is notable that teachers hold positive views and attitudes toward the implementation of formative assessment. Vandeyar and Killen (2007) claim that teachers who view assessment as useful to gather information and use such information to improve learning, will make assessment part of their teaching. While teachers' who do not value assessment will try not to make use of it during their teaching. Findings from the study show that teachers regard formative assessment as strategy that makes learners actively involved as well as making learners think for themselves.

Based on this study, teachers hold positive views toward formative assessment. Teachers' positive attitude toward assessment could be attributed to having an opportunity to attend the intervention workshop on assessment for learning. They all saw the importance of integrating formative assessment as a tool to provide information in order to improve practical activities. Teacher Rumbidzai, for example, described formative assessment as something that she will do to engage with the learners. She further indicated that in the past learners were not actively engaged, but after she started using the Assessment for Learning strategy even the shy learners started to talk.

- **Social interaction**

Black and William (2001) accentuate that learning is driven by what teachers and learners do in the classroom. The teachers have to deal with the skills of asking learners questions, be responsive to learners questions/ comments, and ensure that the interactions flow smoothly and learning is taking place. Analysis of all six practical lessons observed, showed that there was high level of interaction between the teachers and learners and between the learners and learners. The interaction was made possible because of the seating arrangement. In all the practical activities observed, learners were sitting in groups. It was observed that the teachers ensured that there was a rapport between the teachers and learners. The participant teachers considered the importance of interaction among learners.

During lesson presentation learners interacted amongst each other in groups. There were a lot of peers helping each other doing the task and helping those who were struggling. The study

findings are supported by Palinscar (1998), who emphasises that learners' interactions such as those achieved through classroom discussion are thought to provide mechanisms for enhancing higher order thinking. In a similar study on AfL conducted by Willis (2010), it was found that learners were active participants. Palinscar (1998) consolidates this by stating that as learners participate in a broad range of joint activities and internalize the effect of working together, they tend to acquire new strategies and knowledge of the world.

It was also evident that during group work learners interacted by using their first language and during the presentation of their mind maps they had to do it in English. In addition, Delizia was constantly moving around the groups assisting learners, asking questions and directing them to rectify their errors.

- **Change in disposition toward assessment for learning (formative assessment)**

During classroom observation there was a positive change in how the participating teachers' viewed assessment. In Chapter 4, the baseline study, it was discussed that teachers viewed assessment as an entity that can be used after the lesson presentation. However, it was found that teachers did not recognise using assessment during the lesson to improve learning of practical activities. However, there was a significant change in teachers' conceptions and attitude. After being exposed to the intervention workshop, teachers showed an interest in using the strategies with their own learners during the interview.

Participants described the intervention as a transformation. For instance, Delizia stated that *"what you did with us you transformed, for the past years I have been teaching I have not really come across this"*. The teacher believed that they are transformed and are willing to do more of the nature of these practicals with their learners. Echoing the same sentiments, Rumbidzai stated that *"Initially, I thought formative assessment was more of written work, giving tests but my understanding now this is about the processes that take place in the class"*. It is undoubtedly that there is change in attitude.

Analytical statement 2: Teachers' pedagogical strategies (assessment for learning strategies) used during practical activities

During the classroom observation both teachers used some of the key formative assessment strategies. The teachers tried by all means to incorporate the strategies of formative assessment during practical activities. Some of the Assessment for Learning strategies observed are: learning goals, questioning strategies, wait time and giving feedback. From this standpoint, what follows is the discussion of how the teachers engaged with learners using the assessment for learning strategies.

- **Learning goals**

Sharing the learning goal is one of the strategies central to assessment for learning. In all practical activities carried out both teachers ensured that learners were aware of the learning goal. For instance, it was observed during practical activity 3 Delizia wrote the learning goal/basic competencies on the chalkboard while Rumbidzai read the learning goal to the rest of the class. The teachers saw the importance of stating the learning goals during the practical activities. One of the participants stated that: *You see also learners need to be aware of the learning objectives, so that they know what is expected from them to learn* "(Rumbidzai). Another respondent pointed out that: *I also wanted to introduce learners to the concept of knowing the basic competencies before the practical lesson start as it makes my work easier, learners will listen attentively because they know what they want to achieve.*

The findings resonate well with a study by Gioka (2007), who observed that most teachers presented the learning goals and objectives in the form of key scientific terms at the beginning of a new model or a lesson unit, and summarized them at the end of the lesson, in the plenary session. William (2013) mentions similar sentiments that teachers should share learning goals with their students.

- **Questioning techniques**

Based on the observation, questioning was one of the strategies most used by the teachers observed. The way the teachers utilised questions was in two ways (1) written questions and (2) oral questions. Sullivan (2003) acknowledges that questioning is the key means by which

teachers' find out what pupils already know, identify gaps in knowledge and understanding and scaffold the development of their understanding to enable them to close the gap between what they currently know and the learning goals. Tofade, et al. (2013) advocate that questioning is among the most powerful teaching tools and adopting best practices that can significantly enhance the quality of instruction. This section will thus present how the two teachers used the questioning strategies during the practical activities. It was evident that teachers used questions for different purposes. For instance, the teachers asked questions to elicit learners' prior knowledge, questions that enable learners to clarify, probing questions and questions to enable learners to think deep.

It was observed that teachers recognise the need to use questions during the practical activities. Both teachers tried to ask learners questions that enabled learners to be engaged; to think for the answer themselves. Quality questioning was highly used during the practical lesson. Although teachers believe learners should be asked quality questions, there are instances where the teacher lacks the pedagogical skills of the type of questions the teacher asks in the class. Asking questions is an everyday practice for every teacher. With reference to this, Jones (2005) points out that questioning is something all teachers do naturally as part of their daily routine, but developing the skills associated with questioning techniques presents many challenges for teachers and is something that is developed over time. A study conducted in Turkey, suggests that "In order to ask questions that develop thinking skills, teachers should receive in-service training and attend workshops about questioning techniques" (Kucuktepe, 2010, p. 5195).

It emerged that Rumbidzai asked many questions during her lessons; question after question without allowing enough time for learners to answer the questions. Based on the reflection after practical activity session 1, however, Rumbidzai improved to allow more time for learners to think of the answer.

In addition, learners also completed worksheets. Based on data from the observation and analysis of learners' worksheets, the type of questions asked in the worksheets enabled students to predict and explain and to make use of their prior knowledge. It was evident that learners were not used to the idea of predicting and giving explanation as well as writing their observation and explanations. However, as learners were doing the practical activity they improved more especially with predicting.

- **Giving constructive feedback to learners**

The key feature of giving feedback is to do it during the lesson. It was observed that teachers tried to give feedback during class discussion, when learners had presented their mind maps. Hodgson (2010) emphasises that constructive feedback should be given during the discussions and practical tasks. In addition, teacher Rumbidzai also pointed out that when she gave feedback it was kind of motivating learners to ask more questions.

In the practical lessons observed teachers ensured that they gave feedback to learners. During the post reflective interview the teachers recognised the importance of giving feedback. For instance, Delizia stated that *“if learners are not given feedback then the learners are going to take the wrong feedback and they will carry it up to exam.”* If learners are not given feedback their misconceptions will not be rectified. Rumbidzai emphasised that giving feedback is very important because that is the opportunity for learners to be able to make some adjustment to correct him/herself.

Table 19 below summarises how the teachers used assessment for learning or formative assessment strategies.

Table 19: Summary of how the teachers used the strategies

		Teacher A			Teacher B		
		Lesson 1	Lesson 2	Lesson 3	Lesson 1	Lesson 2	Lesson 3
	Learning goal	✓	✓	✓	✓	✓	✓
Questioning	Quality questioning	✓	✓	✓	✓	✓	✓
	Wait time	✗	✗	✓	✗	✓	✓
Feedback	Immediate feedback	✓	✓	✓	✓	✗	✓
	Students work on the	✗	✓	✓	✗	✓	✓

	feedback given						
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It can be deduced from the table that during implementation teachers made use of the Assessment for Learning strategies. However the way they used them is not quite the same. It is quite positive that all teachers stated the learning goal to learners before starting with the practical activity. Both teachers asked quality questions as well as assisting learners to derive the answer. However, during the practical lesson 1 Rumbidzai did not give enough time for learners to think while the teacher kept on asking questions after questions and in some instance answering questions herself. However, she improved during practical activity 2 as she allowed enough wait time for the learners.

Analytical statement 3: Factors that enable and constrain teachers’ implementation of formative assessment strategies during practical activities

The teachers who participated in the study suggested a number of factors that enabled and constrained the implementation of formative assessment strategies during practical activities.

6.4.1 Constraining factors during the implementation of formative assessment within practical activities

During the interview teachers were asked to state the challenges (constraining factors) that impeded the implementation of formative assessment strategies. For this study constraint factors are factors that hinder effective implementation of either during the lesson presentation or before lesson presentation. The constraining factors that emerge include teachers’ lack of pedagogical knowledge on how to use formative assessment, class size, time and difficulty when designing questions. The factors are unpacked and discussed in details below:

- **Lack of teachers’ knowledge**

The teachers’ indicated that one of the constraints on how to effectively use formative assessment is lack of teachers’ knowledge on how to design questions. Teachers highlighted that setting up questions and practical activity criteria is quite challenging as it requires skills on how to ensure that questions asked enable learners to learn. For instance, Rumbidzai

highlighted that designing assessment tasks and designing assessment criteria can be challenging. Echoing the same sentiments, Delizia also pointed that some of the challenge is how to construct quality questions; arranging questions as well as setting quality questions that enable learners to think critically and be engaged in the lesson. The findings are similar to the study of Ituma, Twoli and Khatete (2015) who found that teachers felt that the approach was very demanding but with time they found the activities very fulfilling.

- **Examination oriented culture**

One of the constraining factors is examination oriented culture. What is referred to as examination oriented culture in this study is teachers teaching to finish the syllabus in order to cover the content to be part of examination. The teachers tend not to use the strategies as they get pressure from regional offices/ school in terms of school ranking as the best performing school and subject. The findings are similar to a study by Yau (2004) that public examinations affect teaching and assessment strategies. The teachers are aiming to finish their syllabus and as a result will not use some of the strategies such as formative assessment strategies'. Echoing similar sentiments, Ndlichako (2015) stated that because of the pressure to reverse the declining trend in performance, teachers use assessment as a tool to prepare students to pass examinations rather than as a tool to enhance teaching and learning. Despite some teachers having been trained, they do not use the learner-centred approach of using Assessment for Learning strategies due to the pressure of examinations. Thomas (2015) also found that teachers in Pakistan are pressurised by the system resulting in them focusing on giving tests and examinations. They also tend to complete the prescribed syllabus and overlook the assessment of the students' knowledge and skills.

- **Teacher-learner ratio**

The teachers also highlighted the issue of teacher-learner ratio as a factor that constrained teachers' implementation of formative assessment. They stated that learners are too many in the class. Large classes can hinder effective implementation of formative assessment. Giving individual attention, giving individual feedback and asking question to most of the students, moving around the group to assist learners can be quite challenging. For instance, Teacher Rumbidzai mentioned that she has an over-crowded classroom making it impossible to give

the necessary guidance to her learners. Some teachers' highlighted that giving individual feedback can be difficult because there are too many learners in the class.

- **Time**

It can be deduced from the teachers' post reflective interview that time is one of the factors that limits the implementation of formative assessment. All participants indicated that time is insufficient to do practicals. For instance, Rumbidzai stated that, *“one of the challenges I experienced is time. You know we are conducting the practicals lessons in the afternoon learners are very tired”* and Delizia also indicated that time was the biggest challenge.

Based on the observation, the time was insufficient in terms of engaging more and providing individual feedback as well as moving around assisting groups. Although the tasks were interesting, time was not sufficient to continue because some of the learners had to travel long distances back home. Thus, the teachers suggested additional time is necessary. The teachers reasoned that if the lesson time could be increased they would have enough time during double lessons and practise more of the strategies during lesson time while learners mind are still fresh.

In addition, teachers also indicated that they require time to plan and prepare the activity a day before the usual activity. Delizia, however, stated that,

“So it was not easy and then during presentation of the activity looking at the time I prepared the activities they were all in the afternoon I assumed that the time we will finish them the activity did not finish at that time.”

Teachers alluded that time is not enough as the duration of the lesson is only 40 minutes. The participants indicated that time is very short and makes it difficult to effectively apply formative assessment strategies. The consequence of insufficient time leads to teachers using some teachers-only teaching theory.

- **Learners' language and expression**

All the teachers indicated that language was also one of the barriers that constrain teachers' implementation of formative assessment. English is the second language and even third language to the learners. It was observed that learners were expressing themselves with difficulty in English. It was also observed that some of the learners were shy to express themselves for fear that others will laugh at them. In groups learners were mostly conversing using the local language yet they had to present in English. However, despite the fact that language was a constraining factor, teachers were optimistic that with time learners will change and be actively involved rather than to be shy. For instance, Delizia stated that:

“It was not really easy but I am impressed with them (learners) they were kind of shy at the beginning but with time they will get used they just need to be assisted and also to have confidence so that they can express themselves”.

The constraining factors discussed above can be changed to enable effective implementation of formative assessment. The next section presents and analyses factors that enable teachers' implementation of formative assessment.

6.4.2 Enabling factors during the implementation of formative assessment

Teachers were asked to state ways or approaches in order to effectively implement formative assessment strategies. For this study the enabling factors are strategies that teachers believe if they can be used or taken in consideration, then formative assessment strategies will be effectively implemented. The enabling factors that emerged from the study are: ongoing teachers' support, and support by regional/circuit facilitator, collaboration among teachers, and teachers' training/incorporate assessment in the university curriculum.

- **Ongoing teachers' support, and support by regional/circuit facilitator**

One of the enabling factors is ongoing support by Senior Education Officer (SEO) or by the delegated Circuit facilitator. It is the responsibility for the SEO to ensure that teachers are assisted, guided on pedagogy and skills they are lacking. In addition it is also their responsibility to demonstrate to teachers as in this case the Senior Education Officer can organise a workshop and demonstrate how to effectively implement formative assessment strategies.

On the other hand the participants also pointed out that the SEO might also lack knowledge on how to implement. For instance, Delizia pointed out that: *They (referring to teachers) just need to be facilitated because even the person who is at the region, the subject advisor might not be ware of those strategies on how to carry out practical activities correctly, what are the right procedures.* The respondent is of the opinion that the regional Senior Education Officer responsible for assisting, mentoring teachers might also not be aware of the strategies, nor of how to effectively carry out practical activities for conceptual understanding.

Thus, there is a call for teachers to be given ongoing support. The SEO should ensure that teachers are equipped with strategies that will help learners to learn. Furthermore, the SEO can visit schools and demonstrate to teachers how to make use of formative assessment strategies. Mokiwa (2014) supports the idea that education authorities and stakeholders should have effective professional development programmes (PDPs) that will enrich teachers' knowledge of inquiry-based instruction. Echoing similar sentiments, Florez and Sammons (2013) suggest that teachers should attend well developed and recognised professional development programmes that help them to develop a flexible and deep understanding of the sense of the approach. If teachers' professional development is taken seriously, teachers will be equipped with the necessary skills. Thus it will result in the improvement of teaching and learning. In agreement, Thomas (2012) puts it in more radical terms by stating that teacher education institutes should reconsider their teachings and there should be more professional development activities inside schools to encourage teachers to equip themselves with contemporary approaches of assessments.

- **Collaboration and Information sharing**

One of the enabling factors mentioned by the participants is collaboration. The teachers felt that if they work together with other teachers they can work together to design practical activity worksheets. By so doing they can learn from each other by sharing ideas. This is revealed by the data from the post reflective interview Delizia emphasized that:

“Like for those of us who are trained when we go back to our school we need to share with our colleague in the department, at circuit level and also at regional level. As enriched as I am with all the knowledge I have gained throughout the course more especially from this workshop I am just not just going to invest the information in my school at least they need to be shared with other schools.”

The participants in this study believe that by sharing with other teachers it will also help them to learn how to implement. It was also observed that both invited other colleagues to join them as they did the practical activity. They stated they also wanted other teachers to observe so that they can try to do it in their subjects.

According to Black, et al. (2002), collaboration with a group that is trying out similar innovations is essential. Teachers who are knowledgeable will help those who do not understand. They can share ideas, their experience and share how they implement better. Black et al. (2002) further emphasise that the support from colleagues is important in overcoming uncertainty, especially when teachers embark on strategies they are not familiar with such as formative assessment strategies.

- **Inclusion of assessment for learning at institutions of higher learning**

Another factor constraining teachers' implementation of formative assessment is lack of Assessment for Learning components at some of the tertiary institutions. The participants indicated that they attended institutions of higher learning while they were called colleges. During the time they were not taught about Assessment for Learning. All participants indicated that they did not implement it before because they were not trained on how to implement formative assessment strategies in their lesson.

Rumbidzai emphasised that: *“Institution of higher should try to incorporate in the curriculum more especially how to make use of assessment throughout the lesson”*. The participant believed that if it can be included in the curriculum, teachers from university/ colleges can be equipped with the skills on how to implement formative assessment. The teachers believe that if that is done it can bring improvement.

One respondent indicated that before she attended the orientation Intervention workshop she use to do it she was just demonstrating and not engaging learners and asking learners questions. The study reveals that due to lack of training on how to implement formative assessment strategies teachers will not make use of the strategies. For instance, Delizia stated that:

“In the past hardly allow learners to predict so when we are doing practical activity we are demonstrating in the middle of demonstrating and presenting the practical activity you are already giving answers yet we do not even ask learners why? Those why questions? Why is it happening and why do you think it is happening?”

This could be attributed to the fact that she did not receive proper training on how to implement formative assessment strategies. Thus a suggestion is made for teachers to be trained on concepts of Assessment for Learning at colleges or university. If teachers are not trained they are not likely to use the strategies. However, it was evident that the training the participants went through was effective. One can conclude that during the intervention workshop they acquired the necessary skills.

- **Curriculum interpretation**

One of the constraining factors mentioned by the participants is how to implement the curriculum. Section 6.3 of the national curriculum for basic Education stipulates that the curriculum should be learning-driven, not assessment and examination driven. Thus the curriculum fully supports that assessment and examinations should be used to support learning (The National Curriculum for Basic Education, 2009). For instance, the curriculum states that assessment has a formative role for learners if and when:

- it is used to motivate them to extend their knowledge and skills, establish sound values, and to promote healthy habits of study;
- assessment tasks help learners to solve problems intelligently by using what they have learned; and
- the teacher uses the information to improve teaching methods and learning materials.

In addition to the curriculum the teachers highlighted difficulty in interpreting the syllabus. Rumbidzai indicated that *“sometime the interpretation of the syllabus is just something that a person cannot easily do. Like for example if you ask me to read the syllabus rationale or aims sections it would be difficult for me to interpret.”* The findings from the study reveals teachers are failing to interpret what is referred by the curriculum. Teachers believe they need to be taken through it by those who are knowledgeable. The teachers suggested that; *the senior education need to assist teachers on how to interpret and implement formative assessment.* It can thus be concluded that if teachers are failing to interpret the curriculum documents it will be difficult for them to make use of what the curriculum documents suggest, thus, the formative assessment strategies will be absent in the lessons.

The next section presents the summary of factors enabling and/or constraining teachers’ implementation of assessment for learning.

It can be deduced that participants are faced with common factors that enable and/or constraint as shown in table 20 below. All the enabling and constraint factors mentioned by the participants have an impact on how teachers implement formative assessment strategies. Thus teachers need to be assisted and mentored on how to make use of assessment for learning strategies.

Table 20: Summarised factors that enable/ constrain teacher’s implementation of formative assessment

Teacher	Factors that enable and/or constraint
T1	Designing of worksheets, time, class size, language, curriculum,
T2	Time, planning of task, learners’ expression in English, class size, Interpretation of curriculum, Support from senior Education officer.

6.5 Concluding remarks

During the observations, it emerged that the two teachers seem to have a reasonable understanding of what formative assessment is, as well as its role in teaching and learning. For instance, the participants were able to implement some of the assessment for learning strategies learnt during the professional development workshop. It is recognised, however, that apart from the benefits of employing formative assessment strategies, the challenges that come with it cannot be ruled out. The challenges the teachers face include among others: teachers’ lack of knowledge, lack of sufficient time, curriculum interpretation, lack of support and learners’ proficiency in language. As a way to mitigate the challenges, teachers suggested ways on how to effectively implement assessment for learning.

In the next chapter, I present a summary of my findings, make recommendations based on my findings and propose areas for future research.

CHAPTER 7: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

The purpose of this study was to investigate science teachers' conceptions and dispositions towards the implementation of assessment for learning during practical activities. The study aimed also to look at factors that enable or constrain teachers' implementation of Assessment for Learning. This study provided insight into how a professional intervention programme enhances teachers' pedagogical knowledge and skills. Several researchers have advocated for improvement of teachers skills through professional developmental programme as suggested by Jane (2012); Iileka (2010); Kucuktepe (2010) Ndalichako (2015) and Nyambe (2008). Research has shown that teachers' conceptions impact on the way they teach (Jane, 2012; Rashid & Jaidin). It is known also that the way teachers conduct practicals is ill conceived (Hodson, 1990). Research has shown that if assessment for learning is done well it can have positive impact on learners' performance (Black & Wiliam, 2002). It is against these findings that this research study will assist us to review our own practice of doing practical activities and help us to see that apart from the delivering of content knowledge, teachers need to have pedagogical knowledge.

In my study, I used social constructivism (Vygotsky, 1978) and pedagogical content knowledge (Shulman, 1987). The study analysed teachers' conceptions and how an intervention in the form of a workshop influences teachers' dispositions.

This chapter presents a summary of findings based on each research question. Furthermore, some recommendations and areas for future research are suggested. The chapter ends with some discussions of the limitations of the study.

7.2 Summary of findings

This study was undertaken to get some insights into science teachers' conceptions of and disposition toward the implementation of assessment for learning (formative assessment) during practical activities. The study was guided by one main research question:

- *What are science teachers' conceptions of and dispositions towards the implementation of assessment for learning (formative assessment) during science practical lessons?*

In order to answer the research question, the study was guided by the following research sub-questions as summarised below:

Research sub-question 1:

What are science teachers' views and experiences of the implementation of assessment for learning during science practical lessons?

The question was to get a contextual overview of teachers' beliefs, attitudes and experiences teachers hold toward assessment for learning. Marshall and Drummond (2006) and Thomas (2012) argue that teachers' views and experiences affect the way they apply Assessment for Learning in their teaching. In trying to analyse the data from questionnaire and presented in Chapter 4, it can be summarised that the initial findings reveal that teachers view assessment in different ways and lack a common understanding of the role of assessment. Vandeyar and Killen (2007) posit that teachers who view assessment as important made use of it during their lessons while teachers who do not understand and value importance of assessment avoided using the assessment strategies. They further argue that teachers cannot use assessment strategies they do not understand. This argument resonates well with research findings as teachers reflected that they only use assessment after the lesson. Teachers expressed that they know assessment strategies and make use of them. However, when they were asked to give details of assessment strategies teachers rather described components of summative assessment. It can be concluded that there is mismatched understanding between formative and summative assessment as alluded to by Ndalichako (2015). Such conceptions pose the question of how teachers use assessment in their lessons.

Research sub-question 2:

What factors influence the science teachers' views and experiences on the use of assessment for learning (formative assessment) during science practical activities/work?

In the questionnaire teachers highlighted some of the factors that influence their conceptions. The analysis of teachers' responses reveals that teachers' implementation of assessment for learning is influenced by factors such as teachers lack of knowledge on how to use formative assessment, learners' attitudes, examination oriented culture, class size, teacher work load, insufficient time and lack of learners' motivation. The findings corroborate with Jane's (2012) study which found that the teachers' conceptions of assessment are affected by different factors such as overcrowding, compliance, time management, policy interpretation and implementation, extra administrative workload and paperwork, support from the departmental officials, training and resources.

In terms of teacher lack of knowledge, teachers in this study highlighted that they are finding it difficult to interpret the curriculum documents as reiterated by Nyambe and Wilmot (2012). They indicated lack of knowledge on how to use assessment for learning (formative assessment) as the main constraint. However, teachers suggested enabling factors including amongst other training of teachers on assessment, workshops, collaboration and incorporation of assessment as part of the University curriculum in order to optimise conducting of practical activities.

Research sub-question 3:

How does the intervention in the form of a workshop on assessment for learning (AfL) and practical activities influence science teachers' conceptions and dispositions towards the use of assessment for learning (AfL)?

The findings from this study showed that after the intervention in the form of a workshop the participating teachers do seem to have good understanding of what Assessment for Learning (formative assessment) is, as well as its role in teaching and learning. These teachers showed a positive attitude in using formative assessment strategies. Teachers were able to engage with students by trying to ask learners quality questions, giving immediate feedback and aiding peer assessment among learners. They all shared similar sentiment that using assessment for learning strategies helped their learners to learn as learners were actively involved in learning

scientific concepts as proposed by Vygotsky (1978). However, teachers need to improve to allow enough wait time for learners.

It is thus evident that professional development is essential in shaping teachers' conceptions and understanding of Assessment for Learning. In my view, this intervention played a great role in the professional development of teachers since teachers are faced with dual tasks of teaching as well as using different pedagogy. In the context of this study, the intervention was a gateway in providing teachers with the necessary skills so that teaching and learning takes place. This argument is in line with sentiments by Castle (2014), who highlights that professional programmes can provide great opportunity for teachers to learn new skills, build on their existing knowledge and clear misconceptions they might have.

The study further reveals that in order to effectively implement assessment for learning strategies there is need for ongoing professional development support.

Research sub-question 4:

What factors enable and/or constrain science teachers' conceptions and dispositions towards the implementation of assessment for learning (AfL) during their science practical lessons?

The findings of this research question are presented in Chapter 6. Analysis of teachers' implementation of assessment for learning reveals that teachers are faced with constraining and enabling factors. The findings revealed that during the lesson observations, the participants were able to implement some of the assessment for learning strategies during their science lessons. Some of the enabling factors for instance is teachers' positive attitudes, resilience and willingness to use the strategies. These findings resonate well with findings by Young & Jackman (2014), who posit that teachers' positive attitudes are necessary.

Additionally, teachers believe on-going support will enable them to improve their pedagogical skills. They realised that using easily accessible resources during the practical activities enabled learners to be actively involved during the lessons. The two teachers indicated an improvement in their learners' participations if they are encouraged and motivated to take part as well as getting support from their peers. It emerged that although learners are still to cope with the

strategies, teachers are optimistic that once they get used to them they will become independent and face minimal challenges.

Notwithstanding this, the results showed that there were some constraining factors namely, lack of understanding of some of the strategies i.e. wait-time, insufficient time and learners' proficiency in language. The teachers highlighted that those constraining factors can be transformed into enablers when teachers collaborate by planning together, designing worksheets together, information sharing with those who are knowledgeable. They further highlighted that they needed to be given on-going support so that they can fully implement assessment for learning (formative assessment) strategies in their classrooms.

7.3 Recommendations and areas of future research

This study has revealed the importance of professional development taking into consideration the implementation of assessment for learning (formative assessment). Hence, the following recommendation is suggested in order to strengthen the implementation of assessment for learning.

- Institutions of teachers' training should include component of assessment for learning in their curriculum. The study found out that teachers were not taught assessment for learning (formative assessment) while at colleges/universities.
- Teachers should recognise assessment for learning as a tool that can be used to improve learners' performance. Thus, science teachers should try and incorporate assessment for learning (formative assessment) strategies during their lesson in order to enhance learning during practical activities.
- There is need to provide teachers with professional developmental programme aimed at empowering teachers with skills on how to make use of assessment for learning strategies. The senior education officers, subject heads and head of departments should ensure that teachers are able to interpret what is in the curriculum. This can be achieved if teachers are provided with opportunities where they collaborate with other teachers, design materials together and share ideas.
- The support to be given to teachers should be ongoing so that teachers are able to reflect and share ideas and find solutions to challenges they face.

Areas of future research

- Another avenue for further research could be, a research focusing on learners' views towards the use of assessment for learning (formative assessment) during practical activities;
- Another study could focus on the effectiveness of professional development support in Namibia;
- Another focus could focus on the implementation of assessment for learning strategies in other subjects; and
- A study to look at the nature of questions and wait time in Life Science/Biology.

7.4 Limitations of the study

- The number of participants for phase three was not that large and the study was carried out only in one region, therefore results cannot be generalised;
- There is very little literature on assessment for learning (formative assessment) written in the Namibian context. Hence, I had to rely on international literature whose context might be different.
- In terms of the methodology used, in order to improve the findings of the study just before analysing the questionnaire on teachers' conceptions and experiences it could have been useful to observe at least two teachers to assess teachers' usage of assessment for learning (formative assessment) before conducting an intervention with them. I believe that by doing so, an opportunity to compare what teachers were doing before and what they are able to do after the intervention workshop could have been created.
- Another limitation could be my presence during the observations as the teachers were putting into practice what they learnt during the intervention workshop. Perhaps, it would have been useful to ask them to videotape their own lessons.

7.5 Conclusion

In this chapter I summarised research findings based on the research questions, presented limitations and made recommendations to relevant stakeholders and for further research. This study discussed the relevancy of using assessment for learning (formative learning) with a view to improve the teaching and learning process. The aim of the study was two-fold (1) to find out

science teachers' conceptions towards assessment and also 2) to improve teachers' conceptions in a form of an intervention workshop with the aim of instilling positive attitudes and disposition and enhancing their professional development. This study has established that teachers have different conceptions on assessment for learning (formative assessment) and these can impact the way they teach. Teachers' conceptions can be rectified if teachers are exposed to teachers professional development programmes to rectify negative conceptions.

To this end, this study has showed that interventions in the form of teachers' professional development workshops can enable teachers to collaboratively work together and share ideas. However, teachers implementation of assessment for learning depends solely on their commitment, resilience, and willingness to improve learners' understanding during practical activities and understanding of learners' needs. I am hopeful that this study provided a baseline on understanding of how science teachers view and embrace assessment for learning during practical activities using easily accessible resources.

7.6 Reflections

Every researcher has a story to tell. After I completed my BEd Hons with Rhodes University in 2014, I actually wanted to rest for a year but I gradually changed my mind and took the challenge. I was so tempted to apply for a Master of Education with the same university. I was admitted and my MEd journey started in 2015. My research journey was a great and invaluable experience characterised by sleepless nights, tears, sweat and great memories. What made my journey so easy is that we worked as a team of MEds guided by the African Proverb "If you want to walk fast walk alone, if you want to walk far walk together". I think my experience wouldn't have been so great without the support of my colleagues. At university level we need to support one another and it is because of the great family members that my journey was not a lonely one.

I remember at the end of the 2016 when I was busy with my thesis write-up my colleagues would encourage me, motivate, and talk to me to make sure that I was doing fine. I wouldn't thank them enough. Thanks for being a good family. Being part of this research group instilled the spirit of team work and the culture of sharing. It was during this journey that I learned on

the verge of giving up should never be one of your option but rather, sit down, examine your life and write a letter to yourself of things that makes you proud.

A great philosopher Socrates stated that “An unexamined life is not worth living”. Completing this research study enable me to examine my life as an individual and as a professional. It enabled me to examine the type of educator I want to be? What contribution to I want to make to the Namibian education system? My interest has been in teachers’ professional development and this study has enlightened on the future I want to pursue and the path to take in my career that is empowering other educators. Certainly, there is a lot of mutual benefits in this!

In terms professional development, this thesis has equipped me with the necessary skills that will help me to tackle challenges that I will counter within my teaching and learning. My current position demands continued development to enhance learning and teaching within my classes to enhance my professionalism. For the development of the educator both as a reflexive practitioner, this journey prepared me well to focus on the issues not being addressed properly. For instance, the interpretation of curriculum documents, the levels of competency of learners and actively engaging with learners, different strategies such as assessment for learning, which was the focus of this study, to improve the quality of teaching and learning. This study has set the ground for me as we seek to address the country’s National Development Goals as contained in NDP 4 and to remain competitive in delivering quality education at all times.

Regarding theoretical framework, Shulman’s Pedagogic content knowledge (PCK) was an eye opener to internalise the influence of theories to teaching. In the past I usually used to focus on the subject content and partly look at the pedagogy. My MEd course has provided me with the theoretical grounding and my teaching background with the practical experience to continue growing as the excellent educator that I strive to be as teachers have a dual tasks of teaching content and employing different pedagogies. Furthermore, I have also learned the importance of researching our own context. I think it is very important for us educators to find solutions to our classroom based problems to improve the teaching and learning process.

As a researcher, I must point out that we should be passionate about our research topics. We need to choose topics close to our hearts. I have also learnt as a researcher that we need to read, read and read more of what other have already embarked on. Thirdly, I have also realised that the importance of doing research *with* your participants rather than *on* them. Too often we research on participants and not researching *with* them and this can create an attitude among people that you just want to research on me and obtain your degree. However, in this research

study the research was both beneficial to me and to the participants. This was evident in their reflections, their commitment, resilience and that the teachers (participants) too learned from this research process. I am hopeful that their participation in this study was beneficial to them but also to their colleagues as they stated that they will share the information with others. It is also worth noting that it is a great learning experience to research as a team. As my study was one of the simultaneous study, this implies that as teachers we can team up work together and find solutions to educational issues and problems.

Lastly, if I am to do this research again there are number of factors I will consider (1) I would opt for a smaller number of participant (2) reduce the number of data collection tools. What I realised is if you have a lot of data collection tools you have a pile of data and this can even result in repetition of data. To the aspiring researcher they should have a reasonable data collection tools and reasonable number of participants otherwise they will swim in a pool of data. As I have already emphasised that my journey was not a walk in the park but if I can do it, you too can do it. As one of the great South African leaders stated that says “It always seems impossible until it's done”- Nelson Mandela.

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APPENDICES

Appendix 1: Permission letters

Appendix 1A: Participants informed consent letter



RHODES UNIVERSITY

Grahamstown • 6140 • South Africa

EDUCATION DEPARTMENT

Tel: +27 (0) 46 603 8383

Fax: +27 (0) 46 622 8028

PO Box 94, Grahamstown, 6140

E-mail:education@ru.ac.za

07 January 2016

Dear Research participant

Re: Science teachers' conceptions of and dispositions towards the implementation of formative assessment (Assessment for Learning) during science practical lessons

Thank you for agreeing to be a research participant in my study. As per our discussion, my research area is an investigation of science teachers' conceptions of and dispositions towards the implementation of formative assessment (Assessment for Learning) during science practical lessons

The study will be conducted in **three** phases. The first phase requires participants to complete a questionnaire. The **second phase** of the study involves an intervention in the form of a workshop on training participants on the use of formative assessment (Assessment for Learning). After the intervention, **the third phase** of the study requires volunteers for further research on implementation on the use of formative assessment (assessment for learning) during science practical lessons.

Your participation in this research study is completely voluntary and you can withdraw at any time. The data collected in this study will be published as a Rhodes University half thesis. The identity of each participant and their views or contributions will be treated with a high degree of confidentiality and anonymity.

Sincerely,

Felisia Sheehama
Rhodes University
MEd in Science Education Student

Dr K. Ngcoza (Supervisor)
Rhodes University

I agree to participate in the research on condition that I can withdraw at any time.

Name.....

Signature.....

Contact number.....

Appendix 1B: Permission letter to the director

Felisia Sheehama
P.O. box 3645
Ongwediva
28 March 2016

Att: Mr. Laban Shapange
The Director of Education
Omusati Education directorate
P. O. Box 529
Outapi

Dear Sir

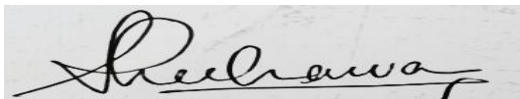
REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN SCHOOLS IN OMUSATI REGION

I am Felisia Sheehama, a Master of Science Education part time student at Rhodes University in Grahamstown, South Africa. I am currently a Science teacher at Ogongo Combined School. My research is in the field of Science Education, with a focus on Formative Assessment. The title of the proposed research is “An investigation of science teachers’ conceptions of and dispositions towards the implementation of ‘Assessment for Learning’ (Formative Assessment) during science practical lessons”. This research will be conducted under the supervision of Dr Kenneth Ngcoza (E-mail: K.Ngcoza@ru.ac.za).

I would therefore like to request for a permission, to conduct a research in two schools in Omusati Region. Ethical issues such respect, confidentiality and honesty will be adhered to. Attached, find a copy of the approval letter which I received from the Rhodes University High degree Committee. Upon request, a copy of the final report will be provided to the Regional office.

If you require any further information, please do not hesitate to contact me on 0813362597 and email address: fsheehama@gmail.com. Thanks for your time and consideration in this matter.

Yours sincerely,



Felisia N. Sheehama (Rhodes University student)

Felisia Sheehama
P.O. box 3645
Ongwediva
28 June 2016

Att:

The Principal



Omusati Region

Dear Sir/Madam

REQUEST FOR PERMISSION TO DO CLASSROOM OBSERVATION

I am Felisia Sheehama, a Master of Science Education part time student at Rhodes University in Grahamstown, South Africa. I am currently a Science teacher at Ogongo Combined School. My research is in the field of Science Education, with a focus on Formative Assessment. The title of the research is **“An investigation of science teachers’ conceptions of and dispositions towards the implementation of ‘Assessment for Learning’ (Formative Assessment) during science practical lessons”**.

I would therefore like to request for a permission, to observe one of the teacher at your school while conducting this Practical lessons. Ethical issues such as respect, confidentiality and honesty will be adhered to. Attached, find a copy of the approval letter from the Director.

Your cooperation in this regard is highly appreciated.

Yours sincerely,

A handwritten signature in cursive script, appearing to read 'Sheehama'.

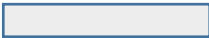
Felisia N. Sheehama

Please put your recommendations in the space below;

.....
.....

Felisia Sheehama
P.O. box 3645
Ongwediva
26 July 2016

Att:

The Principal

Omusati Region

Dear Sir/Madam


REQUEST FOR PERMISSION TO DO OBSERVATION

I am Felisia Sheehama, a Master of Science Education part time student at Rhodes University in Grahamstown, South Africa. I am currently a Science teacher at Ogongo Combined School. My research is in the field of Science Education, with a focus on Formative Assessment. The title of the research is **“An investigation of science teachers’ conceptions of and dispositions towards the implementation of ‘Assessment for Learning’ (Formative Assessment) during science practical lessons”**.

I would therefore like to request for a permission, to observe one of the teacher at your school while conducting this Practical lessons. Ethical issues such as respect, confidentiality and honesty will be adhered to. Attached, find a copy of the approval letter from the Director.

Your cooperation in this regard is highly appreciated.

Yours sincerely,


Felisia N. Sheehama

Please put your recommendations in the space below;

.....
.....

APPENDIX 2: APPROVAL LETTERS

Appendix 2A: Approval letter from the University high degree committee



RHODES UNIVERSITY

Grahamstown • 6140 • South Africa

EDUCATION FACULTY • PO Box 94, Grahamstown, 6140
Tel: (046) 603 8385 / (046) 603 8393 • Fax: (046) 622 8028 • e-mail: d.wilmot@ru.ac.za

04 February 2016

To Whom It May Concern

Re: Proposal and Ethics approval for Felisia Nauvele Sheehama (13S7345)

The minutes of the EHDC meeting of 28 January 2016 reflect the following:

**2016.01.2 CLASS B RESTRICTED MATTERS
MASTER OF EDUCATION RESEARCH PROPOSALS**

Master of Education (Half Thesis)

Felisia Nauvele Sheehama: 13S7345

Title: An investigation of science teachers' conceptions of and dispositions towards the implementation of 'Assessment for Learning' (Formative Assessment) during science practical lessons.

Supervisors: Dr. K.M. Ngcoza and Mr. R. Kraft

Decision: Approved

This letter confirms the approval of the above proposal at a meeting of the Faculty of Education Higher Degrees' Committee on 28 January 2016.

In the event that the proposal demonstrates an awareness of ethical responsibilities and a commitment to ethical research processes, the approval of the proposal by the committee constitutes ethical clearance. This was the case with this proposal and the committee thus approved ethical clearance.

Yours truly

A handwritten signature in cursive script, appearing to read 'M. Graven'.

Prof. Mellony Graven
Chair of the EHDC, Rhodes University

Appendix 2B: Approval letter from the director



REPUBLIC OF NAMIBIA



OMUSATI REGIONAL COUNCIL

DIRECTORATE OF EDUCATION, ARTS AND CULTURE
Team Work and Dedication for Quality Education

Tel: +264 65 251700

Private Bag 529

Fax: +264 65 251722

OUTAPI

Enq: Apollonia Hango

15 April 2016

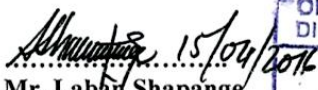
Felisia Sheehama
Ogongo Combined School
Ogongo Circuit

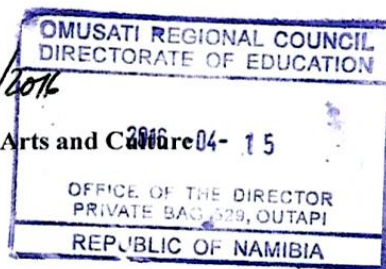
Subject: Permission to conduct research in two schools in Omusati Region

This letter serves to notify you (Ms. Felisia Sheehama) that permission has been granted to conduct research regarding "An Investigation of science teachers' conceptions of and dispositions towards implementation of 'Assessment for learning'. Please be informed that the research to be conducted at schools should by no means whatsoever disrupt teaching and learning.

We hope and trust this exercise will enhance quality education in the Region.

Yours faithfully


Mr. Laban Shapange
Director of Education, Arts and Culture



All official correspondence must be addressed to the Chief Regional Officer.

Appendix 2C: Approval letter from the school (Rudo JS)

Felisia Sheehama
P.O. box 3645
Ongwediva
28 June 2016

Att:

The Principal
[Redacted] Combined School
Omusati Region

Dear Sir/Madam

REQUEST FOR PERMISSION TO DO CLASSROOM OBSERVATION

I am Felisia Sheehama, a Master of Science Education part time student at Rhodes University in Grahamstown, South Africa. I am currently a Science teacher at Ogongo Combined School. My research is in the field of Science Education, with a focus on Formative Assessment. The title of the research is **“An investigation of science teachers’ conceptions of and dispositions towards the implementation of ‘Assessment for Learning’ (Formative Assessment) during science practical lessons”**.

I would therefore like to request for a permission, to observe one of the teacher at your school while conducting this Practical lessons. Ethical issues such respect, confidentiality and honesty will be adhered to. Attached, find a copy of the approval letter from the Director.

Your cooperation in this regard is highly appreciated.

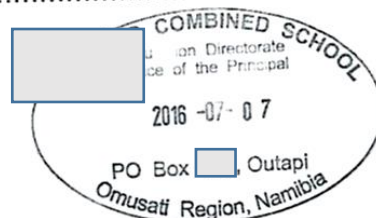
Yours sincerely,

Felisia N. Sheehama

Felisia N. Sheehama

Please put your recommendations in the space below;


.....
PERMISSION GRANTED FOR CLASSROOM OBSERVATION!
.....



Appendix 2D: Approval letter from the school (Rufaro JS)

Felisia Sheehama
P.O. box 3645
Ongwediva
26 July 2016

Att:

The Principal

Omusati Region

Dear Sir/Madam

REQUEST FOR PERMISSION TO OBSERVATION

I am Felisia Sheehama, a Master of Science Education part time student at Rhodes University in Grahamstown, South Africa. I am currently a Science teacher at Ogongo Combined School. My research is in the field of Science Education, with a focus on Formative Assessment. The title of the research is **“An investigation of science teachers’ conceptions of and dispositions towards the implementation of ‘Assessment for Learning’ (Formative Assessment) during science practical lessons”**.

I would therefore like to request for a permission, to observe one of the teacher at your school while conducting this Practical lessons. Ethical issues such respect, confidentiality and honesty will be adhered to. Attached, find a copy of the approval letter from the Director.

Your cooperation in this regard is highly appreciated.

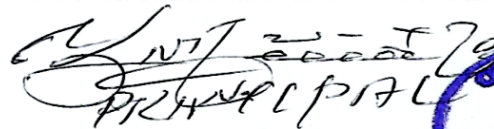
Yours sincerely,



Felisia N. Sheehama

Please put your recommendations in the space below;

.....
*PERMISSION GRANTED TO MAKE HER
OBSERVATION.*
.....


PRINCIPAL



Title: Formative Assessment/ Assessment for Learning in science teaching**TEACHER'S QUESTIONNAIRE****Designed by: Felisia Sheehama****Student number****13s7345**

I am Felisia Sheehama, studying toward MEd degree with Rhodes University. I hereby request you to participate in this research project entitled: An investigation of science teachers' conceptions of and dispositions towards the implementation of Formative Assessment (Assessment for Learning)" during science practical work / activities. The purpose of the study is to understand teachers' views and experiences toward the implementation of formative assessment. This questionnaire A is designed to determine what you already know about formative assessment (assessment for learning). You will complete another questionnaire B again at the end of the intervention workshop. Kindly complete all questions to the best of your ability.

PART A: PARTICIPANT'S PROFILE

1. Age

20-25		26- 30		31-35		36-40		41-45		46-50		Above 50	
-------	--	--------	--	-------	--	-------	--	-------	--	-------	--	----------	--

2. Gender

Male		Female	
------	--	--------	--

3. Region

--

4. Current position

Teacher		Head of Department		Principal		Others (indicate)
---------	--	--------------------	--	-----------	--	-------------------

5. Qualification (tick where applicable)

Certificate in Education (ECP)		BETD		Diploma in Education		Diploma in Education + ACE		Advanced Diploma in Education	
--------------------------------	--	------	--	----------------------	--	----------------------------	--	-------------------------------	--

Bachelor of Education Degree		BEd. (Hons)		Master in Education		BSc.		BA		Other
------------------------------	--	-------------	--	---------------------	--	------	--	----	--	-------

6. Total years of teaching/ working experience

7. Science subjects you teach (Tick where applicable)

Science subjects you teach	(Tick)	Grade
Physical science		
Biology		
Life science		
Agricultural science		
Natural science and Health Education		
Other (indicate)		

PART B: Teachers' beliefs toward Formative assessment (Assessment for learning)

In this section, the aim is to find out about teachers' beliefs/ conceptions toward formative assessment. This is not necessarily looking at how it is in practice. Please tick.

	Strongly Disagree	Disagree	Agree	Strongly Agree	Not sure
Teachers should elicit learners prior knowledge					
Teachers should explain learning goals/ basic competencies to learners					
Teachers should ensure that all learners achieve basic competencies					
Teachers should allow learners to take ownership of their own learning					
Teachers should allow learners to be involved in the planning of activities					

Teachers should encourage learners to be actively involved in the lesson					
Teachers should ask constructive and quality questions					
Teachers should allow wait-time before learners answer the questions					
Teachers should allow learners to pose questions					
Teachers should use assessment criteria to check learners' understanding					
Teachers should give immediate feedback to learners					
Teachers should give individual feedback to learners					
Teachers should give constructive feedback					
Teachers should give time to learners to do correction based on feedback given					

Part C: Teachers conceptions of assessment

1. In your own view, what do you think is the **purpose** of:

(a) Formative assessment

.....

(b) Summative Assessment

.....

2. Give some **examples** of formative assessment classroom strategies in science teaching

.....

3. Do you make use of formative assessment (assessment for learning) in your teaching? Tick

yes		no	
-----	--	----	--

(a) If yes, explain why

.....

(b) If no, explain why

.....

(c) Describe in some details how you use formative assessment (Assessment for learning)

.....

.....

4. Did you receive training with regard to principles/ aspects of formative assessment

(assessment for learning)? Tick in the appropriate box: Yes No

5. Do you believe that there is room for you or other teachers to improve on their classroom skills in formative assessment / Assessment for Learning? Please explain.

.....

.....

6. What possible benefits do you see in using formative assessment (assessment for learning) in science teaching? Give examples.

.....

.....

7. What possible challenges do you see in using formative assessment (assessment for learning)? Please give examples.

.....

.....

8. How can these challenges be overcome?

.....

END!!

Appendix 3B: Collated questionnaire responses

Colour – Teachers’ perceived role of formative assessment

Colour- Teachers’ use of formative assesment either during or after the lesson

Colour – Suggested examples of formative assessment

Colour - Enablers/ Constrain

1. Teachers’ perceived views on the role of formative assessment

T ₁ Q ₁ F	Is to find out or to test, examine if learners’ have achieved the basic competencies in a particular subject.
T ₂ Q ₂ M	To check if learners have perhaps learned the skills as stipulated in the syllabus.
T ₃ Q ₃ F	To assess leaners’ progress, can be done in a mini test or examination learners are aware assessment is being done.
T ₄ Q ₄ F	The purpose is to check learners’ understanding on a daily basis
T ₅ Q ₅ M	To check learners’ progress in terms of the content covered.
T ₆ Q ₆ M	To inform learners about their progress regardless of whether it is formal or informal activity.
T ₇ Q ₇ M	To test the academic growth of the learners. In other words to test whether the basic competencies for your lesson were met
T ₈ Q ₈ M	To check learners’ progress
T ₉ Q ₉ M	To see how or to which extent learning took place.
T ₁₀ Q ₁₀ M	To see the learning progress of learners throughout the lesson/ learning.
T ₁₁ Q ₁₁ M	Help the teacher to see learners’ academic progress, which can be done through class activities, test and homework.
T ₁₂ Q ₁₂ F	To find out if learners have understood what they have been taught and whether learning has taken place.
T ₁₃ Q ₁₃ F	To test whether learners learnt something on what is taught and their understanding.
T ₁₄ Q ₁₄ M	To check the overall progress of the learners for a specific grade
T ₁₅ Q ₁₅ F	To measure the level of learners understanding and see how learners progress with their learning.
T ₁₆ Q ₁₆ M	To test learners understanding of a certain of concept.
T ₁₇ Q ₁₇ M	the assessment that assess the short time concept after a topic or a theme

T ₁₈ Q ₁₈ M	To assess the progress of learners
T ₁₉ Q ₁₉ M	Formative assessment help students to improve on their work and help the teachers to identify areas of focus.
T ₂₀ Q ₂₀ F	Control learning and be able to check the learners' level of knowledge after they are taught.
T ₂₁ Q ₂₁ F	To check whether the learners are progressing well during/ throughout the lesson
T ₂₂ Q ₂₂ M	To tell how well learners master basic competencies for each lesson or topic covered.
T ₂₃ Q ₂₃ M	To check the immediate understanding of the learners
T ₂₄ Q ₂₄ M	To check whether learners have acquire the basic competencies and check the progress. Is the summary of all assessment in a year.
T ₂₅ Q ₂₅ F	Is the assessment in which the teacher allocate marks that will count toward CA at the end of the year.

(b) I (a) Teachers views about the purpose of Summative Assessment

T ₁ Q ₁ F	To examine whether what you are teaching in a specific lesson is achieved throughout the year.
T ₂ Q ₂ M	To assess if learners have mastered the skills taught during the lesson and if able to apply it anymore else.
T ₃ Q ₃ F	To assess learners progress, this form of assessment is a combination summary of different assessment done
T ₄ Q ₄ F	Provides the requirements of being promoted or meeting the passing requirements at the end of the year for a particular grade.
T ₅ Q ₅ M	To check the level of understanding of the learners in all the topic covered.
T ₆ Q ₆ M	To give an overview of the learners' progress at the end of the year on what show the learners performed from the beginning to the end.
T ₇ Q ₇ M	To gain collective feedback on the growth of the learner in the subject
T ₈ Q ₈ M	To determine whether learners will progress to the next level or not
T ₉ Q ₉ M	To sum up all the assessment of the mid-year in order to find the final grade of the learners.
T ₁₀ Q ₁₀ M	To grade and know who has achieve /mastered the grade competences. To go to the next grade.
T ₁₁ Q ₁₁ M	To check the learners understanding throughout the whole year which is done in the final exam.

T ₁₂ Q ₁₂ F	To find out as to what extend have the objectives been achieved.
T ₁₃ Q ₁₃ F	To proceed to the next grade should they reach achieve the learning objectives
T ₁₄ Q ₁₄ M	To check the progress of learner in a certain topic or theme based on the competencies
T ₁₅ Q ₁₅ F	To find out if a specific learner meet all the competencies' n a certain grade.
T ₁₆ Q ₁₆ M	To test learners progress throughout the year or the term.
	To check the record of the learner throughout the term or year.
T ₁₇ Q ₁₇ M	The assessment that assess the course objectives at the end of the year
	To assess if learners have mastered the skills taught during the lesson and if able to apply it anywhere else.
T ₁₈ Q ₁₈ M	To verify whether the learner has master and ready for the next grade.
T ₁₉ Q ₁₉ M	To keep record of learners assessment work.
T ₂₀ Q ₂₀ F	The purpose is to check if the learning objective of the presentation are achieved at times.
T ₂₁ Q ₂₁ F	To check learners progress
T ₂₂ Q ₂₂ M	To promote learners to the next grade at the end of the year.
T ₂₃ Q ₂₃ M	To check the record of the learners throughout the term or year
T ₂₄ Q ₂₄ M	Is the summary of all the assessment in a year
T ₂₅ Q ₂₅ F	Is the informal assessment were the teacher assess how learners understand the specific topic.

3. Do you make use of formative assessment (assessment for learning) in your teaching?

T ₁ Q ₁ F	At each and every end of module, I have to I give written work to the learners, to see if they have learned basic competencies. However, I also give class work like exercise during the lesson.
T ₂ Q ₂ M	Because it helps me to see how much learners have the learnt during the lesson so that I can find ways to approach those skills which learners did not get.
T ₃ Q ₃ F	I need to keep track of how my learners are progressing. To find out my weakness are as well as my strength and to sustain my strength and improve on my weaknesses.
T ₄ Q ₄ F	I want to check how my learners are progressing

T ₅ Q ₅ M	To find out the progress of my learners, those who understand and those who are still struggling to understand. Those who still need to be given enrichment activities and those who need to be given corrective activities.
T ₆ Q ₆ M	To get an overview of whether there is learning taking place and to what extent. To know where learners are still struggling so that I can adjust or change my teaching methods.
T ₇ Q ₇ M	To test learners understanding of the subject or activity carried.
T ₈ Q ₈ M	To check learners progress.
T ₉ Q ₉ M	To see the degree at which learning has been taking place.
T ₁₀ Q ₁₀ M	It give a true reflection of an individual subject growth and development.
T ₁₁ Q ₁₁ M	I have to test the learners' understanding and to find if they have grasped the content of the topic taught
T ₁₂ Q ₁₂ F	To ensure that the competencies have been achieved and make amendments on my pedagogies
T ₁₃ Q ₁₃ F	To test whether they achieved the basic learning objectives.
T ₁₄ Q ₁₄ M	In order to find out how learners are progressing and have mastered the competencies.
T ₁₅ Q ₁₅ F	To find out the level of learners understanding and help them in order to make some improvement on their learning
T ₁₆ Q ₁₆ M	For me to know how learners progressed (learned) throughout the year. It also help to assess all learners' work.
T ₁₇ Q ₁₇ M	To know the strength and weakness of the learners and provide the room for improvement.
T ₁₈ Q ₁₈ M	To monitor the progress day to day and to ensure learners' have mastered the topic before moving to the next one.
T ₁₉ Q ₁₉ M	It help me as a teachers to know that my students requires help and allow me to plan activities according to the individual abilities of my students.
T ₂₀ Q ₂₀ F	To test the level of learning and to check if learning has taken place.
T ₂₁ Q ₂₁ F	To determine effectiveness of my teaching and whether learners mastered specific basic competencies
T ₂₂ Q ₂₂ M	To see how well learners have mastered the competencies in each topic covered.
T ₂₃ Q ₂₃ M	In order to determine the learner understanding of concepts.
T ₂₄ Q ₂₄ M	I want to know the progress of the learners for the whole year. To see whether learners' have acquire the basic competences.

T ₂₅ Q ₂₅ F	It help to show the understanding of the learners and be able to have the marks at the end of the year.
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(c) Describe in some details how you use formative assessment (Assessment for learning)

T ₁ Q ₁ F	I use formative assessment in the form of tests, topic tasks, practical activities and quiz to the learners.
T ₂ Q ₂ M	I usually design a class activity or a home work and give it to learners to answer questions based on what they have just been taught. Thereafter, I mark the work to see if they have learnt the necessary skills to determine if I have to re-teach the same topic or tackle particular issues of the lesson which were not understood.
T ₃ Q ₃ F	Assessment tasks are set beforehand. Learners are given time to prepare before the date when they need to sit for their task.
T ₄ Q ₄ F	After I teach a topic I give them formative assessment
T ₅ Q ₅ M	I teach a topic to my learners all of them at the same time then give them a test to check their understanding. Then I will give enrichment activities to those completed the test well and give activities to those struggling, re-teach the topic using different method, though due to time most of the time don't do it.
T ₆ Q ₆ M	I use formative assessment on whatever task I give to the learners' for example, after teaching the next day I have to use questions and answer method to check on their understanding. After every written task whether it is going to be recorded or not feedback has to be given.
T ₇ Q ₇ M	blank
T ₈ Q ₈ M	I employ formative assessment after presenting every topic. I give a series of homework, practical write up and finally a test. If learners' did not achieve basic competencies, it indicate that they are not ready to move to the next concept thus I should reflect of my teaching and represent the topic after that I re employ the formative assessment.
T ₉ Q ₉ M	By testing the competencies of the syllabus through giving test, tasks and experiments.
T ₁₀ Q ₁₀ M	To test/assess how much learner mastered and where need improvement.
T ₁₁ Q ₁₁ M	After every topic, I set up a class test/ activity to check the learners' understanding.
T ₁₂ Q ₁₂ F	I use tests, practicals and topic tasks as to check whether learning has taken place.
T ₁₃ Q ₁₃ F	Asking questions in the classroom, giving them tasks to do.
T ₁₄ Q ₁₄ M	blank

T ₁₅ Q ₁₅ F	By giving activities at the end of each topic or end of the term as well at the end of the year.
T ₁₆ Q ₁₆ M	Formative assessment need to be used to assess learners' in different learning objective.
T ₁₇ Q ₁₇ M	After I finish a topic or a theme.
T ₁₈ Q ₁₈ M	After every topic I give a task, then test. But topics that learners need more attention. I use both presentation play, task then finally test.
T ₁₉ Q ₁₉ M	Through tasks, tests and exams, after each chapter I design a task and test for my learners
T ₂₀ Q ₂₀ F	I give them tests every end of topic and I give them examinations to write every term end as it is in the subject policy.
T ₂₁ Q ₂₁ F	I evaluate the performance of the learners and plan correctives for them.
T ₂₂ Q ₂₂ M	blank
T ₂₃ Q ₂₃ M	I give learners exercises to do after I presented my lessons so that they can complete it immediately or at home. Sometime I pose oral questions and give a reward to the learners who give the right answer.
T ₂₄ Q ₂₄ M	After each lesson presentation or topic learners are given formative assessment either in a form of topic task, topic test, practical investigation or project.
T ₂₅ Q ₂₅ F	By giving tests and assignments that are done under supervision.

5. Do you believe that there is room for you or other teachers to improve on their classroom skills in formative assessment / Assessment for Learning? Please explain.

T ₁ Q ₁ F	Yes, there is a room to improve on their skills. Through organising the subject meeting with the other colleagues in the region, circuit or cluster and share ideas on how to do formative assessment on the specific topics or chapters.
T ₂ Q ₂ M	Yes, there is a room for that because without learners being assessed teachers' will never be aware of the standard and level learning is taking place. Formative assessment serves as a mirror or a reflective substance through which we as teachers look back at our work.
T ₃ Q ₃ F	Yes, if teachers' are well informed and they had received proper training then they can improve on mechanism of assessing learners.
T ₄ Q ₄ F	Yes, because some teachers do not have adequate knowledge concerning the type of formative assessment appropriate for each topic as well as the types of questions to ask.

T ₅ Q ₅ M	Yes, is through checking learners understanding that will give a teacher the direction on were their learners are facing items of difficulties experience and to find solution to their problems.
T ₆ Q ₆ M	Yes, we must not only consider formative assessment necessary comparing with formal written work.
T ₇ Q ₇ M	blank
T ₈ Q ₈ M	Yes, by reflecting on one's teaching
T ₉ Q ₉ M	Yes, teachers' should test the critical ability of the learners for them to determine whether learning took place or not.
T ₁₀ Q ₁₀ M	Yes, teachers' need to be coached on how to formulate questions based on blooms taxonomy.
T ₁₁ Q ₁₁ M	Yes, many instance learners fail because of inadequate and poor quality formative assessment. A need of improvement is needed as formative assessment has an impact on leaners' learning progress which leads to their summative assessment.
T ₁₂ Q ₁₂ F	Yes, tasks that teachers give to their learners should reflect exam conditions (questions) as to prepare learners thoroughly by using words that might be used in the exam e.g. Discuss, tabulate, explain, classify etc.
T ₁₃ Q ₁₃ F	Yes, because some teachers do not assess learners regularly.
T ₁₄ Q ₁₄ M	Yes, if teachers are well trained on how to assess their learners using formative assessment, they will improve their skills on how to effectively use it in their classroom.
T ₁₅ Q ₁₅ F	Yes, throughout teaching career, teachers' need to know the level of their learners' understanding and find out if they meet all the competencies for the specific grade which allows them to move from one grade to another grade.
T ₁₆ Q ₁₆ M	Yes, teachers' need to know what is formative assessment and how it is important to assess learners using formative assessment.
T ₁₇ Q ₁₇ M	Yes, if they are provided with proper training.
T ₁₈ Q ₁₈ M	Yes, if they are provided with training.
T ₁₉ Q ₁₉ M	Yes, it is important for us teachers' to give focus and know the level at which our student perform. Assessment will surely differ from one teacher to the other depending on the type of learners being assessed.
T ₂₀ Q ₂₀ F	Yes, because it enable to show you the strength as well as weaknesses of your learners and thus you will be able to apply corrective tasks.
T ₂₁ Q ₂₁ F	Yes, because sometime teachers assess but they do not evaluate and analyse assessment results. Training is needed to help teachers to assess, evaluate and analyse their assessment result in order to improve their teaching to ensure effective learning.

T ₂₂ Q ₂₂ M	Yes, there is a room for improvement.
T ₂₃ Q ₂₃ M	Yes, because teachers' do not do it often enough in order to continuously measure learners' progress.
T ₂₄ Q ₂₄ M	Yes, there still room for teachers to improve on assessment criteria of practical investigation.
T ₂₅ Q ₂₅ F	Teachers helps to have a strict supervision so that the learners will be awarded marks that are corresponding to their understanding.

6. Benefits do you see in using formative assessment (assessment for learning) in science teaching? Give examples.

T ₁ Q ₁ F	The benefit it act as a mirror to reflect where you did well and not through marking your learners work. For example the topics which you find learners did not do well, than you will have chance to do remedial teaching to ensure learners have mastered the basic competencies.
T ₂ Q ₂ M	It helps to move learners from having learning basics to having mastered the skills. It helps the teacher to review his/her own practice of teaching.
T ₃ Q ₃ F	It will help me as a teacher to monitor how the learners are doing in class in terms of content.
T ₄ Q ₄ F	When used effectively it allows learners an opportunity to see their progress in learning
T ₅ Q ₅ M	Make learners' feel part of the group as they are not left behind. Build learners confidence to try new knowledge. It help the teachers to understand of the potential of their learners and how to help them.
T ₆ Q ₆ M	It informs learners regarding their efforts in learning.
T ₇ Q ₇ M	It provides constructive feedback to the teachers on the learners understanding of a certain topic or activity.
T ₈ Q ₈ M	It improve the outcomes
T ₉ Q ₉ M	It helps teachers to know competencies that learners did not understand for the teacher him/herself to re-teach these competencies.
T ₁₀ Q ₁₀ M	Learners will be familiar with how questions are asked and how to tackle them.
T ₁₁ Q ₁₁ M	Through formative assessment, learners will have a better understanding of what is being taught and what is expected from them in their final exam.
T ₁₂ Q ₁₂ F	Teachers' would be able to tell / find out their learners progress and understanding concerning different modules and concepts that they would have covered. Teachers' can be able to evaluate their teaching strategies and make changes where need be.

T ₁₃ Q ₁₃ F	During practical work/ activities learners learn by doing /seeing which helps them to remember when writing exams. Helps them to study and search information, helps them to ask from peers , parents that will enhance their understanding
T ₁₄ Q ₁₄ M	I have no idea
T ₁₅ Q ₁₅ F	Formative assessment gives learners opportunity to learn more on science subjects because the more they do the practice the more they learn a lot.
T ₁₆ Q ₁₆ M	Learner's progress can be assessed throughout the year , not only at the end of the year. A teacher can be able to see and identify where learners still need help .
T ₁₇ Q ₁₇ M	It will help learners to work hard. For example, if learners are to be assessed on a project for marks.
T ₁₈ Q ₁₈ M	It identify who understand and who still need further assistance. Compel teachers to use more than one teaching method.
T ₁₉ Q ₁₉ M	Improvement of results. Improve learners' confidence and willingness to learn. Help the teachers to understand the learners' level of performance.
T ₂₀ Q ₂₀ F	It makes the process of teaching and learning easier because it is a way of controlling the process.
T ₂₁ Q ₂₁ F	Helps the learners to see how they are progressing whether they are doing well or not. Creates the room for the learners to improve.
T ₂₂ Q ₂₂ M	The teacher will be well informed on how well learners' understand the topic. Learners are informed about their progress.
T ₂₃ Q ₂₃ M	Improvement is teaching practice. Enhance learners understanding. Clarify misunderstanding
T ₂₄ Q ₂₄ M	Tell the teachers whether learners have mastered the basic competencies or topic presented to learners. Moreover, it helps teachers to alter the methodologies /strategies in order to meet the needs of the learners.
T ₂₅ Q ₂₅ F	It helps the teacher to determine how far the learners understood the topic and what are the strategies that one has to employ in order to help those who do not understand

7. Possible challenges do you see in using formative assessment (assessment for learning)? Please give examples.

T ₁ Q ₁ F	The way the teacher is organising the questions, lack of knowledge on how to construct questions , setting simple questions, number of competencies to be assessed per topic or chapter. For example, you might find the teacher is just focusing on assessing one chapter more than other chapters which can be a disadvantages.
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T ₂ Q ₂ M	It can be time-consuming because the time allocated for each lesson is very short and makes it difficult to be managed in a short time.
T ₃ Q ₃ F	It requires time for teacher to set up the task.
T ₄ Q ₄ F	Challenges like time, number of learners and teaching & learning aids.
T ₅ Q ₅ M	The way of coming up or setting up quality assessment for our learners.
T ₆ Q ₆ M	I do not see any
T ₇ Q ₇ M	No possible challenge
T ₈ Q ₈ M	Availability of time teach again a certain concept or topic which is not understand by learners
T ₉ Q ₉ M	The challenges include the involvement of different assessment skills in the test like skill A, skill B and skill C.
T ₁₀ Q ₁₀ M	There are challenges on weighting of questions, arranging of questions
T ₁₁ Q ₁₁ M	Learners' can copy answers from one another. Learners' sometimes write to pass but not to know.
T ₁₂ Q ₁₂ F	none
T ₁₃ Q ₁₃ F	Work load of marking of learners' work. We have over-crowded classroom. Time is very limited for practical activities and resources are not available in schools.
T ₁₄ Q ₁₄ M	I have no idea
T ₁₅ Q ₁₅ F	It is time consuming to do many practical investigations or experiments during the lesson instead of teaching about the content of the subject without practical activity.
T ₁₆ Q ₁₆ M	Some content covered might be little to be assessed. Furthermore, it is time consuming. Lack of assessment strategies known by the teacher can also be a challenge.
T ₁₇ Q ₁₇ M	Learners will only learn to pass or to get mark but not to know.
T ₁₈ Q ₁₈ M	Setting standard assessment which includes all skills such as recalling, knowledge with understanding and application of knowledge.
T ₁₉ Q ₁₉ M	It maybe time consuming. Learners may not have interest in doing their work.
T ₂₀ Q ₂₀ F	blank
T ₂₁ Q ₂₁ F	Time constrain to plan and mark necessary assessment items. Assessment results are not always reflecting the potentials of the learners. Maybe, learners failed because they did not study or they pass because they cheat.
T ₂₂ Q ₂₂ M	Giving feedback on every test because learners' are too many (individual feedback that is). Time for correction is limited.

T ₂₃ Q ₂₃ M	Time is not enough to carry it out efficiently. Some learners' are shy to respond to oral questions
T ₂₄ Q ₂₄ M	Designing assessment tasks. Completing assessment forms Designing marking or criteria specifically the practical investigation.
T ₂₅ Q ₂₅ F	The amount of tasks to be given are not enough to test the understanding of the learners. For example, as part of science assessment (continuous assessment) sheet learners' are expected to write only two test. These tests are not sufficient in assessing the understanding of the learners.

Teachers' suggestions on how to overcome possible challenges when using assessment for learning

Teachers code	Teachers responses/ marked text
T ₁ Q ₁ F	To have organised workshops at circuit or region level. Assessment to be incorporated at universities or colleges. Colleagues who have ideas share with others.
T ₂ Q ₂ M	Teachers' can arrange for afternoon hours to do more work in assessing learners.
T ₃ Q ₃ F	Find time in order to prepare learners' task.
T ₄ Q ₄ F	More time to be allocated per topic. Teacher-learner ratio should be considered. Teachers' need to be creative in their assessments.
T ₅ Q ₅ M	By organising workshops for teachers' to be able to set quality assessments.
T ₆ Q ₆ M	<i>blank</i>
T ₇ Q ₇ M	<i>blank</i>
T ₈ Q ₈ M	Offering compensatory teaching.
T ₉ Q ₉ M	Teachers' should be exposed to workshops and training for them to deliberate into this issue.
T ₁₀ Q ₁₀ M	Teachers' should be given workshops on how to assess learners.
T ₁₁ Q ₁₁ M	Quality assessment should be given. Proper and strict monitoring during the assessment should be implemented.
T ₁₂ Q ₁₂ F	<i>blank</i>
T ₁₃ Q ₁₃ F	The government should make provision of resources in schools. Teacher-learner ratio should be looked at and teachers need to be committed to their work.
T ₁₄ Q ₁₄ M	<i>blank</i>
T ₁₅ Q ₁₅ F	As teachers' we need to be well organised with our presentation in order to cover all the components of our lesson presentation.

T ₁₆ Q ₁₆ M	Teachers' need to be trained on how to assess different competencies and on how to organise and use time effectively.
T ₁₇ Q ₁₇ M	Teach to know.
T ₁₈ Q ₁₈ M	Training teachers. Give/provide samples of assessment. Establish independent setters while teachers' only teach.
T ₁₉ Q ₁₉ M	Motivate learners'. Make more time for assessment for instance in the afternoon.
T ₂₀ Q ₂₀ F	<i>blank</i>
T ₂₁ Q ₂₁ F	Give/create enough time to assess learners' activities as required by the subject requirement. Analyse assessment results effectively.
T ₂₂ Q ₂₂ M	Devote enough time for marking (teachers).
T ₂₃ Q ₂₃ M	<i>blank</i>
T ₂₄ Q ₂₄ M	Group designing tasks. Workshop on doing assessment. Group designing of marking criteria.
T ₂₅ Q ₂₅ F	There should be enough time for the assessed task so that all topics can be tested.

Appendix 4: Observation schedule

Topic:

Number of students:

Length:

	Comments
<p>1. Introduction</p> <ul style="list-style-type: none"> • Activity is well introduced • Students are aware of the learning goal and clearly communicated 	
<p>2. Use of Assessment for learning strategies</p> <p>(a) Questioning strategies</p> <ul style="list-style-type: none"> ▪ Teacher ask variety of questions ▪ Teacher ask probing questions ▪ Questions encourage deeper engagement ▪ Using questioning to elicit students thinking- requiring higher order thinking ▪ Questions inclusive of prior knowledge ▪ Questions encourage discourse ▪ Teacher allow adequate wait time when asking questions ▪ Encourage students to ask questions ▪ Students ask questions to seek clarity 	
<p>(b) Feedback</p> <ul style="list-style-type: none"> ▪ Gave students descriptive feedback ▪ Respond to students questions in a constructive way ▪ Feedback is feeding forward to improve students achievement/ draws on students feedback ▪ Provide students with immediate feedback after each assessment task ▪ Students to judge their own learning based on the feedback given/ Students act on teacher feedback ▪ Adequate time provided for reflection 	
<p>3. Social interaction</p> <ul style="list-style-type: none"> ▪ Active engagement with given practical task ▪ Interaction between teacher and student appropriate ▪ Provide direction of discussion ▪ Teacher moves around groups during discussion ▪ Encourage students to express their thought ▪ Students were involved to make concept maps/ mind maps ▪ Allow enough time to complete the task 	
<p>4. Enabler and constrains</p>	

APPENDIX 5: TEACHERS' REFLECTIONS AFTER THE INTERVENTION

Appendix 5A: Reflection guideline

1. This week we carried out some practical activities using easily accessible resources. We also had a workshop on assessment for learning (AfL). Do you have any past experiences in these during your schooling/tertiary studies/teaching experiences?
2. What are your views regarding doing practical activities using easily accessible resources/local material?
3. What are your feelings regarding the approach: Predict → Explain → Explore (practical activity) → Observe → Explain (PEEOE) approach?
4. What are your thoughts toward the use of formative assessment?
5. Has participation in this workshop changed your attitude towards practical activities or not? If so, in which ways? Please explain.
6. Would you recommend the activities and workshops carried out this week to be conducted to other science teachers in Namibia?
7. Any other comments

Appendix 5B: Reflection collated responses

1	This week we carried out some practical activities using easily accessible resources. We also had a workshop on assessment for learning (AfL). Do you have any past experiences in these during your schooling/tertiary studies/teaching experiences?
TR1	I only have an experience especially on diffusion
TR2	No past experience and I have learned a lot from this workshop
TR3	Yes, during tertiary studies and teaching experience
TR4	A bit of experience especially testing of carbon dioxide using a straw
TR5	I had the experience during my high school
TR6	Yes, I have the past experience during my tertiary studies in biology section. I also had an experience of assessment during my teaching experiences.
TR7	There is no activity that I can recall and I have never done one with my learners.
TR8	Only few experience.
TR9	Some of them only, like the preparation and testing of carbon dioxide. I only did not experience the production of hydrogen from reacting aluminium foil and caustic soda.

TR10	Yes, I have attended some workshops on both practical and assessment.
TR11	Yes, a little bit of it and this was necessitated by the lack of resources. I use to do it as a mean of improvising.
TR12	No, I did not think brewing traditional beer we could come up with different scientific concepts and also have assessing learning. But now I am aware that science is everywhere.
TR13	No, I never had an experience on these kind of activities in fact it was really a good learning experience. I could recall some scientific concept used though.
T14	Yes, some of the practical's we did were familiar but most of them were not real familiar for me. Formative assessment is something I heard of but I didn't really implement it in the classroom
TR15	Yes
TR16	Yes, during schooling.
TR17	Not clear
TR18	No
TR19	Yes, during my tertiary studies but it was more laboratory based.
TR20	To a certain extent yes, some of the practicals I have done them during my teaching but not nicely as it was done during the week the part of the assessment was so fascinating.
TR21	Yes, the production of carbon dioxide as well as, brewing of Oshikundu are experienced during the topic of human respiratory system.
TR22	Just a bit, especially on tea bags in hot and cold water about diffusion.
2	What are your views regarding doing practical activities using easily accessible resource/ local material?
TR1	It makes learning interesting and seems simple by the learners
TR2	It is really interesting and I am confident that I will share my knowledge with fellow science teachers.
TR3	It is cheap and capture learners interest
TR4	It is a very good practice that educators need to improve /implement/empower in our/ their teaching practice. It encourage me/ gave me insight that although there is no laboratory at school, I can still use available / cheap materials at home / shop to do practical activities.

TR5	It is should be highly encouraged because we have access to all the resources. It is only that we really do not know to use them in terms of performing practical activities using such resources. I am of the opinion that science teachers should receive proper training on how to use easily accessible resources and how to make use of assessment for learning strategies.
TR6	Using the easily accessible materials it allows all learners to come along or bring their indigenous resources in the classroom instead of buying it from the shop and some of them they cannot afford it.
TR7	It is a great idea, because sometimes the teachers do not do practical activity with reason that there are not chemicals that can be used to carry out experiment. Using local materials, it gives the teacher and learners a chance to carry out experiments.
TR8	This is a good idea because even if you tell the learners to buy it will be easy for them to do it as they are of affordable price. Moreover, they are easy to get as some of them they are using them at home.
TR9	It is a powerful form of doing practical activities because it allows learners to get the understanding that science is around them.
TR10	It was a good experience since my school have enough resources. I will refer leaners to this simple practical so that they will be able to contextualise their knowledge.
TR11	It is easily accessible. Learners know it. Learners feel involved in the learning process. It make learners take owner ship of their learning.
TR12	Very nice and good in the sense that materials of resources does not cost too much to buy them. However even learners can make them using waste materials and learners will be able to improvise the materials from the waste local environment.
TR13	I feel practical activities should really be reinforced in classrooms. I feel that they make learning more meaning more meaningful and fun.
TR15	Making use of what is part of your context or surrounding for experiment purpose.
TR16	It is cheap and learners are used for them and get in touch with them.
TR17	Not clear
TR18	Doing practical activities helps learners to understand and internalise what they are being taught. It helps them to move away from memorising facts rather than observing and prove at some point to how real are the concepts written in our syllabus.
TR19	It is a good things most teachers at remote area more where there is not chemical and science apparatus. It is helpful for teachers to be aware of easily accessible alternatives.

TR20	It was a very good and enlightening practice to carry out this activities. Many of us (teachers) fail to expose our learners to this activities claiming that there are no laboratories or chemicals at school while the laboratory is just the very classroom or the open space that nature provided for the chemicals are just a little finger away from us.
TR21	It is a good idea, as it is cost efficient, it uses readily available resources.
TR22	It promotes learning and encourage active participation because learners are dealing with materials they are familiar with.
TR23	I am seeing it as a wonderful thing to do in a sense that it help learners to create a bridge between their home science and the science that they learn at school. Also it is cheaper as the resources /materials to be used in the practical activities can be generated from the environment.
3	What are your feelings regarding the approach used this week of: Predict Explain Explore (practical activity) Observe Explain (PEEOE) approach?
TR1	It was fantastic approach one can use in learning of science
TR2	It is really promoting thinking and enhance learning
TR3	It is a good idea
TR4	It is a good approach, helping learners to be engaged fully in the lesson, constructs the concepts, observe and drawing up proper conclusion.
TR5	This approach would work if a person has prior knowledge on the issue at hand because it would help them to recall. However, starting with prediction could be a challenge for those who do not possess any prior knowledge on the topic under discussion. I suggest to start with exploration then observe then explain.
TR6	Based on the prediction it allows me to think critical to what will happen. Practical activity plus observation allows me to prove on what I wanted to find out.
TR7	It is a good approach that is it gives a chance to someone to think critically. If might learn something in their discussion, however it is not always an easy task to do considering the time as well as the number of learners in the class.
TR8	This was a very good feelings as we were given the chance to predict or say what will happen before we observe.
TR9	It is a very good approach because it probes critical thinking in learners and can be a better suggestion if everybody else can apply this approach in his /her class.
TR10	It is a good approach since it encourage teachers to make use of learner's pre knowledge.

TR11	If allows learners to think and then later to confirm their assumption. Hence, it is indeed a good approach.
TR12	This is the best approach so far as learners will be able to correct themselves after the practical activity has been conducted. Moreover it broaden the understanding of the learners by exploring more.
TR13	I enjoyed the prediction part, the prediction part makes learners focus to all the learning activities taking place during the lesson as they would want to see if their prediction were correct.
TR14	The approach was good because we had a chance to think for ourselves
TR15	I feel fascinated by this approach as when learners predict it encourages them to enhance their prediction and thinking skills. Learners can also explain by giving multiple perceptions.
TR16	It was excellent as it leads learners from what they think of what will happen before practicals.
TR17	Not clear
TR18	This was a great approach that I could not even use or think of during my teaching. It helped us engaged with our thinking abilities and later see how far or close our predictions were to the observation.
TR19	The approach was good, predict helps learners to recall what they have already learned. The practical activity will serve as technique to confirm their prediction.
TR20	I like the approach, it encourages engagement in fact these lessons where the most enjoyable of the session.
TR21	It was an excellent way of teaching. Learners taught in this way would be given time to think about the aspect / concept before the experiment is done.
TR22	It gives room for students to think, question and explore therefore it is a good approach when it comes to practical activities.
TR23	It is a great approach as it can help students to move from what they know (based on their experiences) to what they are expected to learn.
4	What are your thoughts toward the use of formative assessment?
TR1	It is a great idea as it reveal the extent to which learning take place as teaching goes on
TR2	Formative assessment can build robust understanding of subject/ subject content
TR3	Assessing throughout the lesson

TR4	It is the fundamental principle of learning. It help the teacher to measure, evaluate the learning process in terms of weaknesses and strengths. I am glad to hear that it is an assessment for learning process.
TR5	It is a good idea because we can constantly keep track of how learning is taking place. Whether the learners have leamed or not. It can also help us to improve our own practical because it make us aware of which method are successful.
TR6	My thoughts towards the use of formative assessment is to prepare a quality task to learners, gives a feedback on time and give learners chances to do a self-assessment.
TR7	It is good for each teacher because it is during formative assessment that the teacher will be able to improve teaching and help learners know where they need to make change.
TR8	It was educative, as I have learned that when we are teaching we should not wait until we are done with our topic but we can assess our learners during the lessons. Ask questions to the learners and test their understanding.
TR9	It is an affective form of assessing learners because it is during formative assessment teachers to know if learning has taken places in the class that time and allows then teacher to quickly change him/her approach of teaching a particular topic or concept if he/ she found that it is not effective enough.
TR10	I thought it was meant for promotional purpose only.
TR11	It is also a good tool of determining if learners have master what they have learned.
TR12	Formative assessment is the way out for learners to understand and what the learners has been doing or have been taught and should be encouraged in all lesson plan.
TR13	I feel they should be done throughout the lesson through questioning, feedback and mind mapping concept emerging from the topic.
TR14	Formative assessment is crucial because it help teachers to measure students understanding immediately instead of waiting
TR15	Formative assessment should be necessitated as it acts as an informative mechanisms on what the learners have achieved well and what they use to improve.
TR16	It will help the learners to master the content very well which will be useful in their final assessment (examination).
TR17	Not clear
TR18	This is an important aspect in teaching and learning and it helps a teacher to finds out whether learning has taken place by using questioning strategies and feedback.

TR19	Formative assessment help learners to learn what they fail to understand the concept.
TR20	This is a very crucial aspects that teachers do not do in the classroom where they are doing it, it is not effectively done, this need to be taken a step further so that teacher understand what formative assessment.
TR21	It is a good way of assessing learner's progress and it needs to be carried out on a regular base so that the teacher and the learners would be able to keep track of their strength and weaknesses.
TR22	It is an important in the learning process
TR23	blank
5	Has the participation in this workshop changed your attitude towards practical activities and if so in which way? Please Explain.
TR1	In a positive way I realise that practical activities help learners to understand the topic easily
TR2	Yes, now I know how to do them and apply them in my teaching
TR3	Yes now I can able to prepare practical's activities even at the school does not have science lab or the lab is not equipped
TR4	Yes, It is because all along I use to think that practical activities can be only done in the lab (fully equipped one). But now I developed a positive attitude that I can use available resources in the environment and do practical activities even in my class.
TR5	No, I always believed that practical work is an important part of science learning. It was just a confirmation of my ideas.
TR6	Exactly, I was impressed by lots of practical activities done during the lessons.
TR7	It has changed me, I am that teacher that does not believe in practical activity with the experience that learners do not learn anything. Now I am rethinking my teaching approach. I think I have to change my teaching strategy of conducting practical activities.
TR8	Yes, because we use to give excuses that there are no equipment's at school but now I have an idea that you can get them in shops at a cheaper price or use local materials.
TR9	Exactly, it change my attitude towards teaching learners. I wish my class can be as participatory as the one we had throughout the week.
TR10	Yes, the workshop has encouraged me to use more practical activities in my teaching.

TR11	Yes, using easily accessible learners make the lesson interesting.
TR12	Yes, it changed me in sense that practical activity enhance learning and understanding.
TR13	Very much though not a science teacher but I really want to encourage teachers to do it in other subject too.
TR14	Yes, I started to have good feel about science even though I don't teach it at school. Participants were open and willing to share their experience
TR15	Yes, it has given me an impression that we cannot have assertion of something before carrying out an experiment to test, before assertion.
TR16	Yes, it really changed me through sharing of ideas from colleague.
TR17	Not clear
TR18	Yes, it made me realise how practical activities helps learning and retention of information to the learners. It will be help learners to master and link concepts and develop them too.
TR19	Yes, I got to learn that as a teacher I have to improve learners is practical activity. I learn that practical activities is important and it can help learners to have a broad understanding of new concepts.
TR20	Yes, in a very positive ways. I used to have a negative attitude towards my learners think that learners cannot do practical activities.
TR21	I am more encouraged to engage in practical activities. I also realised that the aspect of 'TIME ' does not really have to be a factor because in fact the learning you are trying /rush to teach theory is actually taking place during practical activity.
TR22	Yes, because I got different views from different people.
TR23	Yes it does, I normally had problems of doing practical activities in Physical science with the learners because I had no idea of where to get the resources. For example, I have learnt how to prepare carbon dioxide (CO ₂) and hydrogen gas.
6	Would you recommend the activities and workshops carried out this week to be conducted to other science teachers in Namibia? Give reasons.
TR1	Yes, because they are quite mentally enriching activities
TR2	Yes, because most teachers ignore the practicals due to their reason that they do not have laboratories.
TR3	All activities were educative and suit our Namibian curriculum. Most of us teachers' do not conduct practical's due to the fact that schools are not equipped resources

TR4	Yes, other teachers should be trained so that they can develop the same attitude.
TR5	Yes, because teachers are unaware of those simple experiments we can carry out. Most teachers are worried about spending their money on things which are bought.
TR6	Yes, all the science teachers needs to conduct the practical activities because science is more about practice that allows learners to observe using their sense organs.
TR7	Yes, this gives an opportunity to the teacher to use the available materials in their environment, sometimes the teacher might not do the practical activity because there are no material.
TR8	Yes, because they were educative practical activity help our learner to understanding better.
TR9	Yes, because they help with the visualisation of science other than just explaining without using experiments.
TR10	Yes because they are contextualised.
TR11	Yes it is interesting to the learners. Learners tend to define science. They use in their everyday life.
TR12	Yes because it through practical activities will learners be able mastered what they have learnt.
TR13	It is fun
TR14	Yes, because that is one way to make science interesting by doing so we can be able to bring the reality into the classroom
TR15	Yes, to move them from the way of being content dependent only while there can be content-dependent (local materials) that can help learners of different learning needs learn better
TR16	Yes, because it is useful to the learners and will create more rooms for learners to explore their environment.
TR18	I highly recommend that this activities should be carried out with other science learners so that it helps them to realise the importance of practical activities to both learners and teachers.
TR19	Yes, most teachers in Namibia interested in carrying out practical activity but they are not access to equipped science lab.
TR20	Very much recommending for that to happen. Many teachers find it difficult to teach from context to content. I am even planning to do this to my teachers in my circuit.

TR21	Oh yes, many teachers out there including me are reluctant to carry out practical activities due to various reasons such as Time- it is time consuming and the syllabus does not allocate time for that. Some believe that they can only do practical in labs, some have no resources and moreover, we have less knowledge on how to access resources within our reach.
TR22	Yes please, it will lead to discovery learning. Learners will discover lots of scientific concept.
TR23	Yes, I strongly recommend it in a sense that it can help the learners to get the test of science, and help them to learn science. Also, It is important because carrying out such activities and workshops can help to improve teachers practice.
7	Any other comments
TR1	n/a
TR2	More practical's activities should be carried out next time.
TR3	More time needed to revise some of the practical activities
TR4	I would like to emphasise that teachers need to change their attitude towards practical activities and assessment this is important as it ensure effective learning.
TR5	I like the demonstration.
TR6	Science lessons need enough time which allow students to do their practical activities.
TR7	It was an interesting week and I have learnt a lot which I will definitely do it with my learner.
TR8	No
TR9	No other comments bust just bring up more practical activities during the next session for us to gain skills and apply them in school.
TR10	No thanks.
TR11	blank
TR12	XX and your team you are asset in my BEd hons course
TR13	blank
TR14	XX is a wonderful presenter and I have learnt a lot from her. She is innovative
TR15	Yes, thanks for entitling us to instilling a positive attitude towards the use of practical activities using easily –accessible materials.

TR16	blank
TR17	Not clear
TR18	Teachers should be helped to changes their attitude toward practical activities and not excuses of unavailability of resources and time constrains.
TR19	The activities were interesting I like the materials used and the presenters explained /told us they the materials.
TR20	Thank for the opportunity offered.
TR21	blank
TR22	Well done XX, YYY and ZZ for a wonderful activity. I learnt a lot from you. Keep it up!!
TR23	I have enjoyed the science practical's for this session and really learnt a lot .What I want to highlight that the practical's were done in a rush after one another and we could not have a chance to really master the steps of doing practical.

Appendix 6: Post interview schedule

1. How do you understand the concept of Assessment for learning?
2. You did practical activities with your learners where you implemented strategies of formative assessment. Could you please tell me what you were hoping to achieve by doing this practical activities with learners?
3. During the conducting of practical activities, you used some of formative assessment strategies. What is the relevancy of asking good questions?
4. What is the relevancy of giving feedback during practical activity?
5. What are some of the challenges you faced when you were conducting this practicals.
6. What possible suggestion do you have pertaining to the challenges you faced?
7. How has the implementation influenced your attitudes toward doing practicals?
8. Would you recommend other teachers' to employ assessment for learning strategies in their class during practical activities?
9. For those teachers who did not attend a similar workshop as you did, In what way can those teachers be assisted to effectively implement formative assessment strategies?

Appendix 7: Samples of intervention worksheets

Name:

Hands-on, minds-on and words-on activity 1

1.1 Preparation of the traditionally brewed non-alcoholic *Oshiwambo* beverage called *Ontaku/Oshikundu*

Ingredients and apparatus/equipment needed:

- *Omahangu* flour
- Flour from *Omahangu*/Sorghum germinated seeds
- Residue from already fermented *ontaku/oshikundu* called *oshipithitho*
- Hot water (just below boiling point)
- Cold water (at room temperature)
- Bucket
- Plastic bottles x 4
- Balloons x 4

Procedure

1. Take a generous amount of *Omahangu* flour and put it in a bucket
2. Boil about 2 litres of water in a kettle and allow it to cool down slightly so that it is just hot enough
3. Pour the hot water in the *Omahangu* flour in the bucket and stir continuously to form a evenly mixed paste
4. Pour about two hands full of the germinated *Omahangu* or germinated sorghum flour
5. Stir continuously until the paste is evenly mixed
6. Continue to stir continuously until the paste reaches room temperature
7. Add cold water (at room temperature) to dilute the paste until it forms a dilute mixture of preferred thickness
8. Pour approximately equal volumes of the dilute mixture into four containers of approximately equal volumes
9. Prepare four different samples (**A, B, C, D**) of the *Ontaku/Oshikundu* as follow:
 - A. *Ontaku/Oshikundu* with *Oshipithitho* and leave it at room temperature (*control*)
 - B. *Ontaku/Oshikundu* without *Oshipithitho* and leave it at room temperature
 - C. *Ontaku/Oshikundu* with *Oshipithitho* and put it in a refrigerator (or allow it to overnight in a cold place outside the room)
 - D. *Ontaku* without *Oshipithitho* and put it in a refrigerator (or allow it to overnight in a cold place outside the room)
10. Once all the four samples of *Ontaku/Oshikundu* have been prepared, put a deflated balloon on the mouth of each bottle **A, B, C, D** and leave it over night (or approximately 5 hours) for further observations the following day. Take pictures of the samples.

Predictions and explanations for predictions

- First *individually*, then *in groups*, predict what you would observe in each of the samples of *Ontaku/Oshikundu* **A, B, C and D** after +/- 5 hours
- Write down explanations for your predictions. What do you think would happen in each sample and why?

	PREDICTIONS	EXPLANATIONS FOR THE PREDICTIONS
A		
B		
C		
D		

1.2 Preparation of yeast and sugar solution

Ingredients and apparatus/equipment needed:

- A plastic bottle (preferably 2 litre)
- Like-warm water
- Yeast sachet
- White sugar
- Brown sugar

Procedure

1. Pour lukewarm water in a container such as a bucket.
2. Add a generous amount of sugar to the lukewarm water (about half a cup)
3. Add one sachet of yeast to the solution
4. Stir continuously until the mixture is evenly mixed
5. Pour the mixture into a 2 litre plastic bottle
6. Put a deflated balloon at the mouth of the plastic bottle
7. Observe for about 5 hours

ACTIVITY: Eggs in different liquids

What we need:

- About 6 eggs per group
- Vinegar
- Lemon juice
- Coca cola
- 6 x beakers
- Distilled water

What to do?

1. Prepare three containers of vinegar (**V1, V1, V3**) of approximately the same volume
2. Prepare three more containers and put lemon juice, distilled water and coca-cola respectively in each of the containers and the volume should be approximately equal to that of (**V1, V1, V3**).
3. Label the containers as **L (lemon Juice), W (distilled water) and C (coca cola)**
4. Immerse an egg in each of the liquids respectively (**V1, V2, V3, L, W, C**). Write down your predictions and explanations for your predictions in the table below. What do you think would happen to the egg in each case (**V1, V2, V3, L, W, C**)?

	PREDICTIONS	EXPLANATIONS FOR YOUR PREDICTIONS
V1, V2, V3		
L		
W		
C		

Name:.....

Continuation of ACTIVITY 2: Preparation of the traditionally brewed non-alcoholic *Oshiwambo* beverage called *Ontaku/Oshikundu*

1. OBSERVATIONS AND EXPLANATIONS FOR OBSERVATIONS

Observe what happens to the samples of *Ontaku/Oshikundu* **A,B, C and D** the following day and write down your observations and explanations, individually and as a group.

	OBSERVATIONS	EXPLANATIONS FOR THE OBSERVATIONS
A		

B		
C		
D		

ACTIVITY 4: The chemistry of Carbon dioxide gas (CO₂)

1. We are going to prepare carbon dioxide gas in 5 ways

1. From the *Ontaku/Oshikundu* practical activity (Activity 2)
2. From exhaled air
3. From reaction of vinegar and bicarbonate of soda (NaHCO₃);
4. From heating baking powder (NaHCO₃)

2. Test for carbon dioxide using lime water

We are going to bubble the carbon dioxide in each of the cases 1-4 above through clear limewater

Predictions	Explanations for your predictions
Observations	Explanations for your observations

GROUP ACTIVITY: SCIENTIFIC CONCEPTS

In your groups, write a **mind map** to indicate as many **scientific concepts** as possible that are associated with the *Ontaku/Oshikundu* ; test for carbon dioxide, pH nature of carbon dioxide practical activities.

ACTIVITY

Eggs and hydrochloric acid

Predictions	Explanations for predictions
2 Immerse and egg in hydrochloric acid solution and make observations. Also explain your observations.	
Observations	Explanations for observations.
3 3 Are there any similarities or differences between the effect of vinegar on eggs and the effect of hydrochloric acid on eggs? Explain in detail.	

ACTIVITY 5: Effect of different solutions on eggs and potatoes

After two to three days, take the eggs from **V1, V2, V3** and place them in three different solutions/liquids. You are also going to prepare three pieces of potatoes of approximately equal sizes which are also going to place in three different solutions/liquids.

Label the containers as **Salt sol.**; **Sugar sol.**; and **Water**. Prepare two containers for each solution/liquid. Put an egg and a piece of potato in each of the containers.

1. Concentrated salt solution (salt sol.)
2. Concentrated sugar solution (sugar sol.)
3. Distilled water (water)

Write down your predictions and explanations for your predictions. What do you think will happen to the potato and egg in each liquid and why?

	PREDICTIONS	EXPLANATIONS FOR PREDICTIONS
Salt sol.		
Sugar sol.		
Water		

ACTIVITY : TEA BAGS

What you need:

- Tea bags
- Hot water (boiling point)
- Cold water (preferably from the refrigerator)

You need to put cold and hot water of approximately equal volume respectively in two different containers

You need to put a tea bag in each of the container

Write down predictions and explanations for the formation of colour in the water.

Also write down observations and explanations for the observations

Tea bag in cold water	Tea bag in hot water
Predictions	Predictions
Explanations for predictions	Explanations for predictions
Observations	Observations
Explanations for observations	Explanations for observations