# TEACHERS' PERSPECTIVES ON EMBEDDING FORMATIVE ASSESSMENT IN GRADE 10 PHYSICAL SCIENCES AT INKOSI SAMBANE CIRCUIT SCHOOLS

**BY**

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## ABSTRACT

Formative assessment is intended to enhance teaching and learning. Given the importance of formative assessment in classroom practice, this study aimed to explore Grade 10 Physical Science teachers' perspectives on embedding formative assessment in a Physical Science classroom in Inkosi Sambane Circuit Schools, with the view to promote the inclusion of best assessment practices within a science context. This study was able to explore Grade 10 Physical Science teachers' perspectives of embedding formative assessment in their classroom practice, ascertain how they were able to accomplish this, determine their challenges that Grade 10 Physical Science teachers' encounter during embedding formative assessment in their classroom practice and to identify the classroom support and guidance that is available to Grade 10 Physical Science teachers in embedding formative assessment in their classroom.

The study adopted a qualitative research methodology. Purposive sampling was employed to select twelve Grade 10 Physical Sciences teachers from the twelve high schools in the circuit. Semi-structured focus group interviews and non-participant's classroom observations were used to collect data from the participants. Thematic analysis was used to analyse qualitative data that was collected through semi-structured focus group interviews and non-participant classroom observations.

The study revealed that the majority of Grade 10 Physical Sciences lack the conceptual understanding of formative assessment as a result some of them struggle to integrate it into their classroom practice. Furthermore, findings on the nature of embedding formative assessment revealed that although participants attempted to use various strategies they are faced with numerous challenges as science teachers hindering effective implementation of the process. In addition, findings indicated that although participants made use of questioning during their science lessons, the majority of the questions elicited lower-order thinking instead of advancing science learners towards higher levels of understanding. Based on the research findings mentioned above, this study recommends that adequate in-service professional development training for science teachers on the implementation and pedagogical content knowledge of formative assessment should be done often so that teachers can support learning and learner achievement. This study also recommends that science teachers should be involved in the design and development of the science curriculum; thus their involvement would improve their instructional practice. Availability and accessibility of relevant learner teacher support material may also support and enhance formative assessment in a science classroom especially in under-resourced schools.

***Key words***: science education, formative assessment & Further Education and Training

## DECLARATION

I, Halalisani Mngomezulu (Student Number: 201231318), hereby declare that this thesis entitled: **Teachers' perspective on embedding formative assessment in Grade 10 Physical Science at Inkosi Sambane Circuit Schools** submitted for the degree of Master of Education (M.Ed.) at the University of Zululand, is my original work both in conception and execution. I have acknowledged and indicated all the sources used or quoted through proper referencing. I further affirm that this thesis has not previously been submitted in any form to any other institution of higher education. This work is the result of my effort through the professional guidance of my supervisors who's their names and signatures appears below.

Candidate: Halalisani Mngomezulu

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Date:

## DEDICATION

This work is dedicated to my late sister, Mumcy Makhosazana Mngomezulu and my late brother Selby Nkwezela Mngomezulu. Thank you all for the support you provided to Mngomezulu's family till the last days you closed your eyes for eternity, may their souls rest in peace, till we meet again in the promised land of joy that is inexpressible and filled with glory.

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## LIST OF ABBREVATIONS AND ACRONYMS

| ABBREVIATION/ ACRONYM | FULL MEANING |
|---|---|
| AITSL | Australia Institute for Teaching and School Leadership |
| ARG | Assessment Reform Group |
| CAPS | Curriculum and Assessment Policy Statement |
| CCSSO | Chief Council of State School Officer |
| CEO | Chief Executive Officer |
| DBE | Department of Basic Education |
| FACT | Formative Assessment Classroom Template |
| FET | Further Education and Training Phase |
| LoLT | Language of Learning and Teaching |
| LTSM | Learner-Teacher Support Materials |
| NCS | National Curriculum Statement |
| NSDC | National Staff Development Council |
| PCK | Pedagogical Content Knowledge |
| P-E-O | Predict-Explain-Observe |
| SMT | School Management Team |
| STEM | Science, Technology, Engineering and Mathematics |
| ZPD | Zone of Proximal Development |

# CHAPTER ONE
# ORIENTATION TO THE STUDY

## 1.1 INTRODUCTION

Teachers typically use a wide variety of instructional and assessment methods as they implement lessons. They use formative assessment along with other instructional strategies to determine what learners have learned and the degree of proficiency of that learning so as to improve teaching and learning within a science classroom. The goal of formative assessment is to collect detailed information that can be used to improve instruction and learners' learning while it is happening. Heritage (2016) defined formative assessment as a continuous way to check and balance teaching and learning and allow teachers to monitor their learner's progress as well as the effectiveness of their practices.

According to Black and William (1998:2) formative assessment may be defined as a combination of "activities undertaken by teachers, or by their learners, which provide information to be used as feedback to modify the teaching and learning activities.'' Thus, in line with Black and William (1998) such assessment becomes formative assessment generally when the evidence is actually used to adjust the teaching and learning process so as to meet learners' specific needs.

In addition, formative assessment helps teachers to identify concepts that learners are struggling to understand, and skills they are having difficulties to acquire (Cowie & Bell, 2010). Furthermore, formative assessment helps learners to develop a strong understanding of their academic strengths and weakness (Hondrich, Hertel, Adl-Amini & Klieme, 2016). Shavelson (2006) argues that teachers conduct formative assessment on a continuous basis with the intention of informing them and their learners about the gaps between what learners know and can do and what they are expected to know and be able to do with immediate effect.

Embedding formative assessment in a science classroom should serve to enrich learners' understanding of science and not simply measure attainment of content knowledge. To this end, formative assessment should be an essential feature of classroom practice since the development and implementation of formative assessment serve to support science standards and promote learning (Atkin, 2001).

## 1.2 BACKGROUND TO THE STUDY

Imenda and Oyinyloye (2019) point out that assessment is considered to be one of the main educational tools available to use for different purposes, among which is to maximise learning as well as to motivate learners, and to improve their performance so that they can meet pre-specified goals and standards. Assessment comprises certain activities that teachers and learners carry out to gain information that is useful to modify teaching and learning. Furthermore, assessment can be used to report on learners' progress and achievement.

The Curriculum and Assessment Policy Statement (CAPS) document for Physical Sciences grades 10-12 defines assessment as the continuous planned process of identifying, gathering and interpreting information about the performance of learners (Department of Basic Education, 2011:143). Furthermore, the CAPS document states that assessment must be mapped against the content, concepts and skills; the aims specified for Physical Sciences enable learners to acquire critical, creative and scientific skills. These skills can be enhanced through the proper embedding of formative assessment in the classroom by the teacher. The potential of curriculum embedded formative assessment is to provide 'thoughtful, curriculum-aligned, and valid ways of determining what students know', without leaving the burden of planning and assessing on the teacher alone' (Pryor, Crossouard & Shavelson, 2008:3).

Evidence (Hofstein & Lunetta, 2004; Department of Basic Education, 2011) indicates that formative classroom assessment must be designed to play a prominent role in assisting learners to learn. For the process to be more prominent, there is a need for a science teacher to be acquainted in advance in both the scientific knowledge that learners are supposed to grasp and the variety of alternatives and problematical ways in which learners may fail to grasp it. For a science teacher to achieve these, there is a need for a great deal of experience in evaluating learners' reasoning skills.

Spaull (2014) argues that in most cases teachers as role players in the science classroom receive little training, if any, and this results in much confusion when it comes to embedding formative assessment to enhance learners' scientific understanding.

The South African Schools Act No. 84 of 1996 states that the primary necessity for the teachers' existence in the classroom is to guide and provide learners with the opportunity to learn. To show the hopelessness of the situation, Loughran (2014) confirms that it is unfortunate that the picture that emerges time and time again is both dire and consistent. Loughran (2014) is concerned that it is not clear to most science teachers how pedagogical content knowledge might enhance formative assessment and learners learning. Pedagogical content knowledge in the formative assessment within the science classroom has been a neglected research area for science and technology education.

Gardiner (2019) is of the view that formative assessment is the 'heart' of continuous learning thus it allows teachers to effectively tailor and adjust their teaching to identify and meet learners' needs and ultimately drive their learning forward (Black & William, 1998; Crooks, 1988; Hattie & Timperley, 2007; Hattie, 2009). According to Gardiner (2019), feedback is seen as a primary component in formative assessment and one of the factors that have the strongest influence on learning. However, the feedback provider must take into account that different learners interpret feedback information in different ways.

Shute (2008), Hattie and Timperley (2007) argue that there is an implicit assumption that for the feedback to be formative and enhance learning, it needs to be formulated, delivered and framed in such a way that it invites learners' active engagement. However, Shute (2008) concluded his argument by shedding light on the fact that feedback is more critical when it is used to alter the gap between the crucial level of performance and the reference level, which seems to be a challenge for teachers to integrate feedback in their classroom assessment.

Embedding formative assessment in a science classroom rests squarely on the availability of time so that the teacher can assess following lesson activities and objectives to enhance learners' understanding with the view to close the gap that exists between scientific knowledge and scientific understanding. A study by the World

Bank (Abadzi, 2007) contends that successful learning objectives should not be expected without sufficient teaching, assessing and practice opportunities. Gillies and Quijada (2008) back up the argument of Abadzi (2007) by asserting that learning and formative assessment depend, to some degree, on time.

Furthermore, Gillie and Quijada (2008:5) warn that 'without adequate time on task and formative assessment, no learning is possible'. Various scholars and researchers mostly make use of the term 'time-on-task' to refer to the amount of time where learners are active participants and engaged in formative assessment. There is correlation among the science teacher, science learner and formative assessment; if one among the three changes, the whole process of scientific learning becomes futile.

This emphasises that embedding formative assessment in a science classroom has to be monitored, supervised and developed by the teacher. When the teacher does the aforesaid, the learners can relate their scientific learning content to the real-life situation. According to the Curriculum and Assessment Policy Statement in Physical Sciences, the science curriculum aims to produce learners who can identify and solve problems and make decisions using critical and creative thinking (Department of Basic Education, 2011).

The science teacher must make science learners discover the explanation of numerous phenomena that they observe or encounter around them. Unfortunately, many of those explanations are difficult and abstract for learners to understand. Thus, the call for thorough research on how science teachers embed formative assessment to enhance learners' understanding of the explanations of scientific concepts so that they become creative and critical thinkers.

It is of great concern that in various countries there is diminishing participation of secondary school learners in science as their major and priority subject. Diagnostic assessment in science education is regarded as key to unlocking learners' interest in the science subject, however, most science teachers do not apply diagnostic assessments to the expected standard (Treagust, 2003). In Australia, Great Britain and France, there are even more dramatic enrolment declines in science participation by learners (Nature, 2002).

However, Treagust (2003) suggests that the use of diagnostic instruments in science classroom instruction as means of planned formative assessment will enable teachers to identify learners' misconceptions in particular areas; it will also be remedial just before the summative assessment takes place. If this happens, learners can then participate or choose science subjects as their majors.

Globally, embedding formative assessment has been a serious issue. In New Zealand, the *Learning in science project assessment* research study focused on investigating the proper ways of embedding formative assessment in a science classroom by taking into consideration the learners' thinking capabilities (New Zealand Educational Ministry, 1994). The findings of the study suggested that formative assessment in the science classroom must produce learners with vast knowledge. The legitimate question would be whether science teachers have adequate skills to embed formative assessment in their daily lessons in the classroom.

However various scholars, including Kampourakis (2018), ascertain that some scientific concepts are difficult and abstract for learners to understand; they consist of a broad array of conceptual views, ideas and skills. Moreover, some learners in the science classroom possess incorrect and naïve ideas about the world around them. Mouton, Louw and Strydom (2013) affirm that learners are unable to engage with the content and are also affected by a lack of support as a result of teachers' lack of assessment skills.

However, scholars (Harrison, 2015; Pine, Messer & John, 2001) support the argument about science learners who possess naïve ideas and misconceptions; they concluded their argument by stating that misconceptions in the science classroom are solid cognitive structures that affect learners' understanding of scientific concepts, which can be very challenging to change.'' Collectively, the literature reviewed on the background of the study reflects in the fraternity of Science education nationally and internationally; much research is needed to close the gap within this educational discourse when it comes to embedding formative assessment.

It is noted that science teachers embed formative assessment in their classroom practices without necessarily considering the degree of understanding that learners possess. However, feedback, time on task and pedagogical content knowledge must be considered when teachers embed formative assessment in their classroom practices.

### 1.3 STATEMENT OF THE PROBLEM

Research shows that learners enter Science classrooms with their explanations for scientific phenomena, which are often functional in everyday life but more or less incompatible with scientific conceptions (Hardy, Jorven, Moller & Stern, 2006). However, some researchers argue that teachers do not use formative assessment strategies systematically during classroom instruction when addressing students' alternative conceptions (Morrison & Lederman, 2003; Noyce, 2011). Furthermore, research shows that some essential quality features of formative assessment are often not regarded by teachers. These include the time and effort required for the preparation of incorporating formative assessment in classroom practices (Lee, Feldman & Beatty, 2011).

Various researchers have proposed initiatives that can enable teachers to effectively integrate formative assessment in Science classroom(s). Such initiatives include teacher professional development (Torrance & Pryor, 2001; William, Lee, Harrison, & Black, 2004). However, teachers repeatedly experience challenges in implementing formative assessment strategies during intervention studies (Furtak, 2008). These challenges include low motivation and a poor knowledge base of embedding formative assessment that seems to hamper effective integration (Dixon, Hawe & Parr; 2011).

Meanwhile, research by Ruiz-Primo (2010) shows that formative assessment is not used effectively by teachers especially when a new method is employed. Additionally, research shows that teachers display low self-efficacy in teaching science (Mulholland, 2004). Therefore, teachers are expected to face difficulties in realising formative assessment in a science context. Thus the need for this study to determine the challenges faced by Grade 10 Physical Sciences teachers in embedding formative assessment in the daily lessons.

There is an existing problem on the ground indicating that the performance of Physical Science is rated very low in Inkosi Sambane Circuit schools; this based on the Department of Education performance statistics, comparing different subjects. Therefore, the researcher intends to find out how teachers embed formative assessment in Grade 10 because this grade is the starting point of the FET phase where the science foundation must be laid. Moreover, the researcher intends to find out the support and professional development that teachers receive to effectively integrate formative assessment.

Hoover and Phelps (2008) assert that teachers need to be acquainted with the content and how to teach and assess to achieve quality education. This may be realised through adequate support and training. Grossman, Loeb, Cohen and Wyckoff (2003) state that effective teaching can be described as practices predictive of learners' learning, which can be developed in teacher training or professional development programmes. Unfortunately, few teachers understand the pedagogical implications of their roles in utilising formative assessment as a way of teaching in a science classroom (Atkin, 2001).

A comparative study on teachers' assessment practices indicates that when teachers held traditional and fixed views of learning, their learners' abilities were more likely to perceive external constraints. Therefore, standardised testing in the form of summative assessment seems to inhibit the use of formative assessment (Marshall & Drummond, 2006). Meanwhile, Jone and Moreland (2005) found weak pedagogical content knowledge (PCK) to be another mediating factor in formative assessment practices within the science classroom.

The impact of professional development on teachers' formative assessment practices has been well reported in science education (Feldman & Capobianco, 2008; Torrance & Pryor, 2001). For example, Feldman and Capobianco (2008) worked with high school Physical Sciences teachers to improve their use of science-embedded formative assessment. Meanwhile Black and William (2004) recommended that teachers need tools and professional support if they are to implement high-quality assessment and use formative assessment outcomes effectively.

## 1.4. AIM OF THE STUDY

The study aims to explore Grade 10 Physical Science teachers' perspectives on embedding formative assessment in a Physical Science classroom in ISambane Circuit schools, with the view to promote the inclusion of best assessment practices within a science context.

### 1.4.1 Research Objectives

This study seeks to:

- Explore Grade 10 Physical Science teachers' perspectives on embedding formative assessment in their classroom practices.
- Ascertain how Grade 10 Physical Science teachers embed formative assessment in their classroom practices.
- Determine the challenges that Grade 10 Physical Science teachers encounter during embedding formative assessment in their classroom practices.
- Identify the classroom support and guidance that is available to Grade 10 Physical Science teachers in embedding formative assessment in their classroom practices.

Based on the aim stated above, the study poses the following research questions:

### 1.4.2 Research Questions

- What are Grade 10 Physical Science teachers' perspectives on embedding formative assessment in their classroom practices?
- How do Grade 10 Physical Science teachers embed formative assessment in their classroom practices?
- What are the challenges that Grade 10 Physical Science teachers encounter during embedding formative assessment in their classroom practice?
- What classroom support and guidance are available to Grade 10 Physical Science teachers in embedding formative assessment in their classroom practices?

## 1.5. DEFINITION OF OPERATIONAL TERMS

It is necessary to clarify the following terms that will be used in the study:

### 1.5.1. Assessment

According to Cowie and Bell (1999) assessment refers to the wide variety of methods or tools that teachers use to evaluate, measure, and document the academic readiness, learning progress, skill acquisition or educational needs of learners. This study will consider formative assessment where the teachers can identify individual learner weaknesses and strengths to provide academic support.

### 1.5.2. Curriculum and Assessment Policy Statement

The Curriculum and Assessment Policy Statement is a revision of the previous National Curriculum Statement (NCS). CAPS gives teachers detailed guidelines of what to teach and assess on a grade-by-grade and subject-by-subject basis. The main aim of CAPS is to lessen the administrative burden on teachers and ensure consistency and guidance for teachers when teaching (Department of Basic Education, 2011).

### 1.5.3. Circuit

Circuit offices are local hubs of Provincial Education Departments and provide a vital lines of communication between the Districts, Provincial head offices and the education institution in their care and their task is to work collaboratively with Principals and teachers in schools.

### 1.5.4. District

A School district is a leadership that provides a critical link between most educational reform initiatives and their consequences for learners’ achievements by bridging the interaction between schools and provincials governments.

### 1.5.5. Formative Assessment

According to Wiliam (2011) formative assessment refers to a wide variety of methods that teachers use to conduct in-process evaluations of learner comprehension, learning needs, and academic progress during a lesson, unit, or course. Formative assessment help teachers identify concepts that learners are struggling to understand, skills they are having difficulty acquiring, or learning standard they have not yet achieved so that adjustments can be made to lesson.

### 1.5.6. Further Education and Training Phase (FET)

According to CAPS (2011), the FET phase runs from Grade 10 to Grade 12 in public and private schools. It includes career-orientated education and training. Physical Science is one of the subjects offered at the FET phase thus this study will deeply focus on Grade 10 Physical Science. The mission of the Department of Education to introduce the FET Phase was to build up individuals who can thrive in a working world and provide adequate support for the betterment of society.

### 1.5.7. Physical Sciences

Physical Science is the subject that investigate physical and chemical phenomena. This is done through scientific inquiry, application of scientific models, theories and laws in order to explain and predict events in the physical environment (Department of Basic Education, 2011).

## 1.6. INTENDED CONTRIBUTION TO THE BODY OF KNOWLEDGE

The study investigated how Grade 10 Physical Science teachers embed formative assessment in their classroom practices to enhance learners' scientific and conceptual understanding of the subject. It is envisaged that the findings of this study will assist science teachers to effectively adopt quality formative assessment practices into the teaching and learning process. It may also have the potential to inform the Department of Basic Education regarding where the learning gaps exist among teachers so that they may design and develop relevant professional development activities to enhance teachers' practices.

Even though the Department of Basic Education provides teachers with guidelines and detailed formative assessment policies, this study will probably provide insight into the current formative assessment practices and the challenges that science teachers experience so as to empower them to modify and strengthen their practices accordingly. In addition, this research can benefit the Department of Basic Education in its endeavour to provide substantial support and develop quality formative assessment tools to improve science teachers' classroom practices to enhance learner achievement in science education.

## 1.7. PRELIMINARY CHAPTER DIVISION

The study is organised into five chapters as follows:

**Chapter 1**

This chapter focuses on the introduction and orientation of the study; it explains the purpose, significance of the study and the objectives of the study. Key concepts and research questions are also defined.

**Chapter 2**

This chapter outlines the theoretical framework that underpins the study. This chapter also contains a literature review that covers studies which have been conducted in national and international contexts. It also focuses on the contextualisation of formative assessment in the South African curriculum. This chapter also explores different challenges Grade 10 Physical Sciences teachers encounter while embedding formative assessment.

**Chapter 3**

This is a methodology chapter that covers the research design and methodology used to conduct the research, as well as the data collection instruments used. Sampling methods employed in the study have been explained in the chapter and ethical and safety considerations are also covered.

**Chapter 4**

This chapter reports on the data generated through semi-structured focus group interviews and non-participant classroom observations.

**Chapter 5**

This is the final chapter of the study; it provides a summary of key findings for the study, conclusions concerning the findings based on the objectives of the study. Recommendations are also outlined in this chapter concerning the findings, and the recommendations for further research are also provided.

## 1.8. CHAPTER SUMMARY

This chapter provided the introduction and orientation of the study, the problem statement, aim of the study, research objectives, research questions, definition of operational concepts and the contribution to the body of knowledge. The next chapter discusses the theoretical framework that underpins this study and the literature review.

# CHAPTER TWO

# LITERATURE REVIEW AND THEORETICAL FRAMEWORK

## 2.1 INTRODUCTION

The previous chapter provided an orientation to the study which included the problem statement, aim, objectives, research questions, definition of operational terms and the intended contribution to the body of knowledge. This chapter begins with a brief discussion of the theoretical framework underpinning this study, which is the Sociocultural Theory by Vygotsky. It also continues to discuss broadly the concept of formative assessment and the key principles to consider when embedding formative assessment in science teachers' classroom practice.

Quality results in science at Further Education and Training (FET) phase depend on the solid background of Physical Sciences teaching and learning, therefore, this chapter continues to discuss in detail the strategies science teachers at secondary school can integrate into their classroom practice during embedding formative assessment These include Predict-Explain-Observe, card sort, concept-cartoons, questioning, feedback, peer assessment and formative use of summative assessment.

The literature reviewed also delves into the rationale of incorporating professional development to assist science teachers to effectively embed assessment for learning in their classroom practices. In addition, the contextualisation of formative assessment in the South African curriculum has been discussed in depth together with the Curriculum and Assessment Policy Statement (CAPS) and its implications. The chapter explores and concludes with challenges science teachers encounter when embedding formative assessment in their teaching and learning particularly in high school.

## 2.2 THEORETICAL FRAMEWORK

Different philosophies underpin various research studies. These philosophies are regarded as theoretical frameworks; they are the parameters upon which the study will be discussed. In this study, the researcher briefly explains the key elements of the theory that underpins it and also provides the rationale for adopting this theory in relation to the embedding of formative assessment in a science classroom.

### 2.2.1 Socio-Cultural Theory

The theory underpinning this study is the Sociocultural Theory by Vygotsky, where he described human learning as a social process and the origin of human intelligence in the society or culture. He stated that humans use tools from culture such as speech and writing to mediate their social environment. Vygotsky believed that the internalisation of these tools lead to higher thinking skills. Furthermore, he mentioned that through adult guidance, the child can perform various tasks with adequate assistance, and, therefore, emphasises the Zone of Proximal Development (ZPD) where adults guide and collaborate with children for them to perform tasks. Moreover, he stresses that through interaction, much development takes place. The figure below demonstrates how ZPD occurs in a classroom setting.

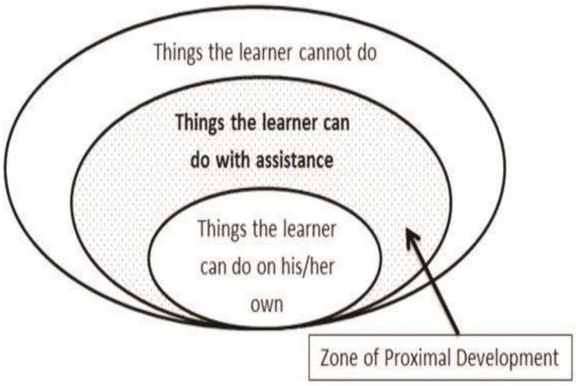


***Figure 1***. ZPD by Vygotsky (Source: Bekiryazıcı,2015)

The rationale for the adoption of this theory in this study is that within the context of embedding formative assessment in the classroom practices, Sociocultural theory enables both the teacher and the learner to realise the roles of formative assessment, observe challenges within the context and think about seeking a solution to improve teaching and learning. Furthermore, among the objectives of this study, the researcher seeks to explore how Physical sciences teachers embed formative assessment in their classroom practices, thus the sociocultural theory emphasises that through formative assessment teachers provide feedback to adjust ongoing teaching and learning to improve learners' achievement of intended instructional outcomes.

Formative assessment merges with the sociocultural theory of learning in a number of ways; thus, we can deduce from a sociocultural perspective that formative assessment takes into account the role of interaction and joint collective action in the learning process. Assessment is not unidirectional, but rather involves both teachers and learners through reciprocal activities which are characterised by them engaging together in responding to evidence about learning, minute-by-minute, day-by-day (Leahy, Lyon, Thompson & William, 2008) thus enhancing the teaching and learning process.

Through the provision of scaffolding, including feedback, self-monitoring and self-regulation on the part of learners' sociocultural theory plays a more prominent role. Through the varying degrees and nature of feedback, as a part of embedding formative assessment, learners engage with teachers to achieve lesson objectives, thus they are adopting the socio-cultural perspective. Also drawing from a sociocultural perspective, the formative assessment takes place within a community of practice.

The teacher and learners participate in the community whereby they assume roles, goals, practices and norms for interaction that are intended to support learning (Duran, 2010). The norms established in the community are mutual support, trust, respect and collaboration. In this study, Vygotsky sociocultural theory will be applied in order to trace the extent to which learning is recognised from a sociocultural perspective through interaction with others. Most importantly, through the sociocultural theory, all learners are recognised and valued as people who gain experiences and knowledge during the process of formative assessment in the science classroom.

## 2.3 THE CONCEPT AND KEY PRINCIPLES OF FORMATIVE ASSESSMENT

According to the Chief Council of State School Officers (CCSSO), formative assessment within the classroom practices is a process used by teachers and learners during instruction. This assessment provides feedback to adjust ongoing teaching and learning to improve learners' achievement of intended instructional outcomes thus the gap that exists becomes closed. Imenda and Oyinloye (2019) assert that assessment for learning (formative assessment) is critical and plays an integral part in teaching and learning in the classroom practice. Notably, the literature reveals that the concept of formative assessment can be used interchangeably with 'assessment for learning'; however, scholars such as Dufresne and Gerace (2004) in the United States also make use of the term 'assessing-to-learn'.

Scholars (Bell & Cowie, 1999; Bennett, 2011) state that formative assessment can either be planned or interactive, with the interaction being a formative assessment that occurs spontaneously in a classroom in an unplanned way. In addition, other scholars (Jone, 2005; Bennett, Kingston & Nash, 2011) provide an understanding that formative assessment is all about informing learners about their progress to empower themselves to take the necessary actions to improve their performance and it is widely considered crucial to effective instruction.

However, Wiliam (2011) and Keeley (2015) claimed that formative assessment could bring benefits to learners when implemented correctly, learners thinking can become more explicit during the inquiry, as learners can be encouraged to predict outcomes supported by evidence from their prior knowledge and experiences, which is rather critical in science education. Research studies (Ruiz-Primo & Furtak, 2007; Black & Wiliam, 2011) within the context of formative assessment in the classroom practice deduce that formative assessment can be defined in various ways, but, notably, these concepts do have common elements.

Black and Wiliam (2011) are of the view that formative assessment as an instructional method has a considerable potential to enhance learning; they make the use of 'What' and 'When' to better conceptualise and locate the meaning of the concept of formative assessment. Thus, the 'What' element are all assessment activities undertaken by the teacher and learners in the classroom setting which provide the information as feedback for future usage to modify teaching and learning activities while learners are actively engaged. Specifically, with the ‘When’ element, assessment becomes formative when all the activities undertaken by teachers and learners in the classroom to meet learners needs and achieve the expected outcomes. Similarly, Wylie (2011) posits that activities become more formative when adapted to bridge the existing gap between learners’ level of understanding and the targeted learning objectives.

On the other hand, Young and Kim (2010) referred to the concept of formative assessment as a ‘flexible instructional method’ because it is the assessment methods that allow learners to undertake various activities that help them to learn and become active participants during the process of classroom instruction. Furthermore, Young and Kim conclude their conceptualisation of formative assessment by emphasising that it is the ‘heart’ of assessment that allows teaching and learning activities to be modified and adapted. Wiliam and Leahy (2007) argue that in the formative assessment, the fundamental need for modification and adaptation is to achieve and meet learners’ needs.

The effectiveness of formative assessment is dependent on learner’s accurate perception of the gap, as well as their motivation to address it. However, Sullivan (2003) and Postholm (2012) explain that questioning within the context of formative assessment is the means by which teachers can find the prior knowledge in learners, identify gaps in knowledge and understanding thus scaffolding the development in order to close the gap that exists between what they know and learning goals as stipulated by Vygotsky’s Sociocultural theory on Zone of Proximal Development. Although many scholars explain formative assessment through different perspectives, thus far there is no solid or stable definition of formative assessment as an instructional method used by teachers.

However, the researcher’s intention in this study is to provide an in-depth understanding of how scholars conceptualise formative assessment; the transition of formative assessment into practices requires some degree of understanding. Wiliam (2011) stated that to effectively implement formative assessment in one’s classroom practice, the teacher as an instructional leader must possess certain elements, such as a deep understanding of curriculum, an understanding of learners’ learning as well as the ability to design and modify learning as part of continual process based on effective feedback. Moreover, the Curriculum and Assessment Policy Statement

(CAPS) document (Department of Basic Education, 2011) examines necessity of assessment in the classroom practices, it, therefore, emphasises that assessment should be both informal (formative assessment) and formal (summative assessment). In both cases, regular and constructive feedback must be provided to learners to enhance their learning experience.

Linquanti (2014) states that formative assessment requires a clear articulation of learning goals and an orientation towards understanding, rather than solely evaluating learners' learning. Although different scholars have defined teachers' formative assessment practices in slightly different ways, Ruiz-Primo and Furtak (2007) argue that formative assessment has common formulations, which include eliciting, interpreting and responding to evidence of learners' thinking. Concerning eliciting, the teacher checks prior knowledge of learners about the task, while interpreting refers to teachers analysing learners' thinking and the teacher responding in the form of feedback.

However, Anderson and Palm (2017) delve deeper in analysing the formulation of the concept of formative assessment; they state that formative assessment entails collecting information about learners' thinking with regard to the activity presented to them. Moreover, interpretation involves making sense of learners' ideas and understanding that may cause a learner to think in a particular way. Anderson and Palm (2017) concluded their argument by shedding light on the element of "responding" in the formative assessment practices that it can be in the form of feedback to learners or instructional judgement to be made by the teacher.

According to the Assessment Reform Group (ARG) (2002), scholars (Black & Wiliam, 1998); Shepard, 2000) stated that assessment for learning is the continuous process of gathering and interpreting evidence of learners' learning to create a 'learning culture, where both teachers and learners are learning so as to identify the next learning goal. However, learners need to decide the best ways these learning goals can be achieved., It can be stated without hesitation that formative assessment plays an integral part in enhancing learners' understanding of the lesson presented to them.

Formative assessment is increasingly becoming a focus area in policy documents on educational assessment and in the professional development of teachers. This implies that the backbone of learners' understanding lies in the effective implementation of formative assessment. Bell and Cowie (2000) are of the view that the term ‘Formative Assessment’ is not new, but rather is now being used in more detailed and specific ways; they further alluded that the concept of formative assessment can also be referred to as the process used by teachers and learners to recognise and respond to learners learning to enhance learning.

In the United States, for instance, Wylie and Lyon (2015) conducted a qualitative study with a sample of 202 Maths and Science teachers. The study explored the dependability of formative assessment implementation in their classroom practices. The findings revealed that when teachers embed formative assessment, both teachers and learners use the evidence of learning to adapt teaching and learning to meet immediate learning needs, minute by minute and day by day. This implies that the conceptualisation of formative assessment requires some degree of carefulness; when teachers embed this instructional method, certain principles should be followed so as to achieve the learning objective and for learners to learn.

According to Clark (2010), the following key principles are recommended to be taken into consideration when embedding formative assessment: learners must be able to understand what they are learning and what is expected of them from the onset; learners must be provided with feedback regularly about their learning and on how they can improve their learning, so they need to be motivated on sustaining their improvement while learning is in place. Clark (2010) also recommends that learners must be included in decision making on what they are going to learn next to avoid unnecessary confusion. However, it shall be the duty of the teachers to seek different sources that can help learners’ learning, it is suggested that they have full access to such sources so that they can build knowledge meta-cognition, an attribute teachers need to strive towards.

The learners' needs are also regarded as key elements that teachers must carefully consider in their classroom practice. Wasserman (2012) posit that for the needs of learners to be attained, teachers must adopt the policies and procedures of inclusive education to support learners’ learning, especially those who have barriers in learning. Assessing learners’ understanding is another core element that should be emphasised because learning is not about recalling what you know, instead it is about assessing the level of understanding. Thus, teachers need to identify specific and measurable learning objectives so that effective assessment of learners' understanding is done (MacLellan, 2020). However, Black and Wiliam (2001) emphasise that feedback as an element of formative assessment must meet learners needs, therefore, any feedback that does not lead to change in learners' learning is redundant; teachers must be clear to learners on what difference they want to see from them - this is referred to as the 'action point'. Lastly, another important key element that teachers must take into consideration whenever a formative assessment is taking place is learner involvement; through this process learners develop high-order thinking skills to solve problems around them. Thus, they become more creative and promote development in thinking and writing skills which are vital in science education.

Collectively, various research studies provide different definitions regarding the concept of formative assessment; moreover, similarities, principles and key elements also exist among these views. However, some definitions focus more on a particular aspect; for example, instrument versus process, or learner-centred versus teacher-centred. Bennett (2011) deduces that the concept of formative assessment is accompanied by confusion, as it lacks a unitary definition of what exactly formative assessment is designed to achieve, thus it may come as a challenge to teachers since the concept itself is rather vast. It may be deduced that how formative assessment is embedded during classroom practices varies.

## 2.4 THE NATURE OF EMBEDDING FORMATIVE ASSESSMENT IN SCIENCE TEACHERS' CLASSROOM PRACTICES

### 2.4.1 Key elements to consider when embedding formative assessment

Teaching and learning do not take place in a vacuum, the teacher who embeds assessment must consider some key elements during the process of embedding formative assessment to enhance learners understanding and meet the diversity of learners in the classroom (Centre for Educational Research and Innovation, 2008). The critical key elements that need to be considered are discussed below.

The first key element is about the establishment of a classroom culture that encourages interaction and the use of assessment as a tool. Notably, teaching and learning are so much more important than just creating lesson plans and delivering the content matter to learners, instead, a positive classroom culture must be encouraged. The teaching environment is equally as important as the actual lesson. In the United Kingdom, the Board for Teachers (2018) posit that learners excel in a space that they feel comfortable in, so if a teacher is to focus on the content delivery only, that teacher shall be missing a critical piece of the puzzle.

It can be contended that a positive classroom must be encouraged as it is beneficial to both teachers and learners to create a classroom where all learners feel part of something great while the lesson is in place. Thus, The Board for Teachers (2018) collaboration recommends few strategies to establish a positive classroom culture, and these are: setting class rules together with learners, turn problems into teachable moments, chat with each learner individually to identify their problems and give out work to learners to make them actively engaged and feel part of the assessment. However, the work must change every week to give all learners equal opportunities.

Secondly, the key element for consideration is the establishment of learning goals and tracking of individual learner's progress towards those goals. Generally, the starting point for all effective instruction is designing and communicating clear learning goals with learners just before embarking on the lesson. Marzamo and Brown (2009) stated that there is great confusion around differentiating between learning goals and learning activities, especially how they interact in the implementation of formative assessment in classroom practices. Furthermore, these researchers clarified that learning activities are used by teachers so that learners achieve learning goals.

For instance, a science teacher can provide learners with learning activities in a science classroom to achieve specific learning goals. This implies that to achieve learning goals, the learning activities must be well stated before the lesson begins - something most teachers fail to do. The qualitative study conducted by Mahajan and Singh (2017) in Malaysia revealed that when embedding formative assessment, learning goals provide a clear articulation of ideas on what is going to be achieved by joining particular pieces of activities together. In the learning context, the learning goals should be well stated at the beginning of the lesson, thereafter the teaching context, assessments and learning activities must be mapped and designed properly to successfully achieve the learning goals. This is critical not only in a science classroom but for every other subject too.

Thirdly, the next key element to be considered is the use of varied instruction methods to meet the diverse learner's needs; some teachers may not prefer to teach learners with the autism spectrum, learning disabilities, anxiety disorders or emotional disorders as instruction for such learners can be very challenging. A study by Wasserman (2012) on the strategies for meeting all learners' needs suggested that for teachers to support learners to meet their needs, they must have an understanding of the difficulties learners are facing. However, Wasserman proposed that teachers need to consider certain aspects when embedding formative assessment to meet learners needs which are: organising tutors to assist learners and appreciate learners needs, make adjustments that shall make a difference in learners' needs and emphasize the benefits and barriers associated with those adjustments.

Fourthly, the use of a varied approach to assessing learners' understanding must also be carefully considered. There are many approaches to assessing learners' understanding, including formal or graded measures of assessment and also informal, ungraded and feedback opportunities. A precisely planned assessment is sustainable and helps learners with the skills to meet their future learning. MacLellan (2020) proposed that for approaches to be suitable for learning, they should consider the following ways: designing an assessment plan, aligning assessment with learning objectives, and making assessment sustainable.

Fifthly, the element that should also be considered is feedback on learner performance and adaptation of instruction to meet the identified needs; feedback can be an effective way of learning when it is used correctly. Feedback should be encouraging and constructive to meet learners' needs. Busch (2016) suggested that better feedback can enhance learner performance by correcting learners quietly because learners with special needs care a lot about what their peers think of them. When the teacher gives feedback in front of other learners, it can be seen as an attack if it is not well handled. Another suggestion is that teachers should not compare learners with others when giving feedback as this could be discouraging. In addition, feedback tends to address the different aspects of the student learning, importantly the causes of their mistakes and how best for them to be corrected (Voinea, 2018).

Sixthly, another key element to be considered is to activate the involvement of learners in the learning process; this element is defined as an instruction method that engages learners in the process of learning (Bonwell & Eison, 1991). Active learning requires learners to do meaningful activities and have an idea about what is going on while the lesson is taking place. The study by Bonwell and Eison suggested that for this element to be effective, learners must actively participate in class discussions, small group discussions, and debate or even in a form of peer assessment. When the teacher embeds formative assessment, the teacher needs to activate learner involvement which includes promoting of the development of learners thinking and writing skills, allowing learners to experiment using ideas from peers, and ensuring active involvement to enhance high order thinking skills. Notably, these key elements recommended by the Centre for Educational Research and Innovation (2008) provide a good foundation for science teachers to strengthen their classroom practice.

### 2.4.2 Different strategies to consider when embedding formative assessment

Effective science teachers set and adopt realistic teaching strategies that allow learners to be explorative to boost their scientific understanding that may result in creative and critical thinking skills. Keeley (2016) and Tugel (2018) identify three crucial strategies a science teacher can employ while embedding formative assessment to enhance scientific understanding, and these are: Predict-Explain-Observe (P-E-O) strategy, Cards Sorts strategy and concept cartoon strategy. They further provided a key reason behind using these aforementioned strategies, stressing that they are useful as they engage and motivate learners. They encourage learner discussions by providing the feedback needed to promote thinking. Furthermore, the strategies inform instruction and enhance learners' understanding of abstract and difficult concepts, particularly in a science classroom setting. The paragraphs below delve deeper into the aforementioned strategies and scientific examples (scientific phenomenon demonstrations) are provided about how science teachers can embed formative assessment in their classroom practice, thus relevant to Physical Science as in the case of the current study.

**Predict-Explain-Observe (P-E-O) strategy**

Generally, the Predict-Explain-Observe strategy (P-E-O) is used in a science classroom when teachers embed formative assessment mostly in an experimental lesson where learners are permitted to predict outcomes, explain their understanding and observe the real result of the experiment. Tugel (2018) recommended that this strategy is useful when implementing formative assessment as it lays the foundation for science practices of developing explanations among teacher and learners as the scientific experiment is taking place. Wiliam (2018) adds that the P-E-O strategy in a science classroom can be used to provide stimuli for scientific discussion and initiate a scientific enquiry, an exploration of ideas and reflection, which ultimately enhances learners' learning.

This scientific strategy begins with the teacher presenting a scientific phenomenon in a science classroom in front of learners. Secondly, learners are permitted to predict the outcome of the scientific event before the actual results are presented, lastly, learners are then given an opportunity to explain their predictions by sharing what they think they will see and why they think so. Notably, Tugel (2018) places the teacher as a central pillar to successfully tailor this strategy, because the teacher during this strategy has the responsibility to carry out the actual experiment and observe the outcomes. Learners should analyse and discuss the results to see if they match their original prediction.

For instance, a science teacher can teach about the density of an object when it is placed in water, so learners can make predictions whether it will either sink or float. Basically, their predictions shall be based on the observable properties such as size, weight or heaviness of an object, then support their prediction with explanations that use the observable properties of an object. To provide assurance and confirmation of their predictions, the teacher would need to carry out a practical demonstration about the phenomenon for reliability and validity. Scholars (Keeley, 2016; Tugel, 2018; Wiliam, 2018) find this strategy important for formative assessment as it provides teachers with insights into the misconceptions learners hold before engaging in an inquiry that are then used to facilitate the learning process.

Even though this strategy has a significant impact on embedding formative assessment in a science classroom, its weakness is that it seems to work properly only when the teachers are implementing the lesson about experiments only, and science learning is not only about experiments. Therefore, the Card sorts strategy by Keeley (2016) below can act as a supplementary strategy when embedding formative assessment, not specifically on the experiments only.

**Card Sorts Strategy**

Effective implementation of formative assessment in a science classroom requires teachers to identify prior knowledge that exists in learners so that they can build on their existing knowledge. Keeley (2016) posit that the card sort as a formative assessment strategy can be used to assess prior knowledge and activate learners thinking capabilities. She outlines that this strategy can be used in a science classroom as learners work in pairs or small groups and are provided with a set of cards related to a category associated with a specific scientific concept or idea. Notably, Wiliam (2011) emphasises that Card Sorts can be used across all learning areas or subjects, not specifically for science learning.

According to Keeley (2016), during the sorting process, learners must justify their thinking and develop rules or reason for their decisions. However, the sorting of cards becomes formative as the teacher observes where those small groups are placing their cards and listens to the groups; subsequently, the whole classroom discussion takes place to inform the next step during instruction. The findings from the two scholars (William, 2011; Keeley, 2016) reveal that the Card sort strategy shows positive outcomes as it promotes collaborative learning among learners because they discuss their ideas, listen to the ideas of the peers and modify their thinking accordingly, thus encourages active learner engagement.

Across various grades, card sorts have been regarded as the heart and powerful tool for reflection and identifying prior knowledge. For instance, Cornelius (2013) posit that in the United States, the Ministry of Education designed the Formative Assessment Classroom Template (FACT) for Grade Levels: kindergarten, on how these teachers can effectively use Card Sort as a strategy. The template promotes learners learning in various ways; it requires learners to group according to various attributes, communicate justification of categories, and helps learners to understand and accept multiple ways of sorting that may differ from theirs and still be correct. This strategy of embedding formative assessment adopts the Vygotsky's socio-cultural theory because learners work collaboratively to sort the cards based on their pre-existing knowledge; however, more development results from the teacher's guidance in a form of Zone of Proximal Development and scaffolding. Based on the advantages mentioned above, it can be assumed that cards sorting as a strategy during embedding formative assessment can contribute meaningfully to the betterment of learners' learning. In addition to strategies discussed so far, other research studies propose concept-cartoon as another strategy that can be embraced by teachers when embedding formative assessment in a science classroom.

### Concept-Cartoons

Effective implementation of formative assessment entails that teachers employ the metacognitive strategy of concept cartoon as it enhances learners' formulation of facts to understand the scientific concepts. Research (Keogh, Naylor, & Wilson, 1998; Sexton, Gervasoni, & Brandenburg, 2009) indicates that concept cartoons are defined as visual tools in which cartoon characters declare views about an event from daily life. However, it should be noted from the study by Ndalichako (2015) that states that concept-mapping can be used interchangeably with concept cartoons as it has the same elements.

Naylor and Keogh (2013), in their qualitative research study that was conducted in Turkey, found that concept cartoons offer an effective formative assessment tool which helps teachers in discovering and challenging learners' epistemic and conceptual knowledge. As teachers discover learners' conceptual knowledge, it can therefore be drawn that a constructivist pedagogical approach is an underlying pillar adopted. The use of concept cartoons motivates learners to actively construct and master correct scientific concepts through collaborative dialogue and argument (Ormanci & Sasmaz-Oren, 2011), thus it is effective during formative assessment.

In agreement, Gardiner (2019) conducted a qualitative research study in England on the episode of interaction on formative assessment with primary school science teachers. Gardiner findings share the similar discourse that the concept cartoons help to provide the opportunity where all learners can freely share their thoughts, debate with each other, suggest explanations and defend their reasoning, thereby enhancing substantive learner engagement. However, the gap has been identified by Gardiner (2019) that when reflecting on a lesson delivered, the teacher may discover that the concept cartoon statements may be a little challenging for some of the lower ability learners to understand fully what is expected of them when they are utilising concept cartoons in a science classroom. In line with Gardiner's concern, Hooij's (2013) work published in Netherlands titled *'Effectiveness of concept cartoons and self-explanations to promote sixth-graders data-reading and theory-revision skills'* investigated whether eleven-year-olds can benefit from concept cartoons that are supported with self-explanation prompts.

The random sampling of 45 learners was employed under three conditions: a control condition with 14 participants, a concept cartoon condition with 15 participants and a concept cartoon plus self-explanations prompts condition with 16 participants. However, Hooij (2013) investigated three variables: cognitive conflict, data reading and theory revision when using concept cartoon as a means of embedding formative assessment in primary school science. The results showed no significance and less coherence among the three variables especially to learners with lower capabilities, thus these findings resonate again with Gardiner's recommendation that whilst learners are fully capable of understanding, some of the lower ability learners may need further prompting to draw their ideas and understanding as teachers adopt concept cartoons during their formative assessment tasks to achieve the learning goals about a certain scientific phenomenon.

Likewise, it needs to be ensured that all concept cartoon statements are written in learners' language, especially in lower grades at primary school science classrooms so that all learners can fully understand the nature of the activity before it is administered to them. Other effective strategies that might be productive for teachers in a science classroom could be questioning, feedback, peer and self-assessment and the formative use of summative assessment. These additional strategies allow learner engagement while the lesson is in place; moreover, scientific understanding of scientific concepts can be enhanced through them.

**Questioning**

The primary purpose of using questioning as a formative assessment strategy is to find out what learners already know in order to channel the lesson towards what they need to know and be taught next. Grant (2014) of the Australian Institute for Teaching and School Leadership CEO (AITSL) proposed another purpose of employing questioning while embedding formative assessment which is to teach learners to think critically because questioning requires deep analysis rather than a simple yes or no answer or recalling of information. AITSL further imposed critical techniques to successfully tailor questioning when embedding formative assessment in a science classroom practice.

The teacher can adopt these strategies by, firstly, focusing on questioning as part of lesson planned and making sure that all questions are clearly formulated to avoid confusion and misunderstanding of scientific concepts among learners in the classroom; secondly, the teacher can use a random pointing method to ensure that all learners are answering questions. Thirdly, the teacher can increase the wait time to provide learners more time to think so that they come up with meaningful answers' however too much of waiting could slow down the pace of the lesson, which it is unacceptable. Lastly, if learners answer the question with 'I don't know', be sure to come back to them later after responses have been modelled to get more clarification and understanding of what further support they might need.

Even though questioning seems to be a useful and recommended strategy across various grades and phases, teachers are still not effectively adopting this strategy during formative assessment. Florez and Sammons (2013) conducted a qualitative study in England to explore the importance of teachers using the questioning strategy to support and guide learners' learning. The findings of the study revealed that teachers were often not sufficiently challenging learners, thus suppressing learners' critical thinking skills. In addition, Florez and Sammons (ibid) indicated that time was of serious concern, as learners were given a short period to elaborate on their understanding.

In agreement, Myhill and Dunkin (2007) conducted a more or less similar study in the United Kingdom with a sample of 54 teaching episodes under the classroom observations; the findings revealed that the function of many questions does not frequently attempt to elicit thinking to learners. Instead, questions were shallow and required merely recalling, not really improving higher-order learning.

However, Chin (2006) in Singapore conducted a qualitative study titled '*Teachers Questioning in a Science classroom: Approaches that stimulate productive thinking,'* in which he employed purposive sampling in large-scale classes where English is taken as a medium of instruction; six teachers teaching Grade 7 from four schools were selected. The purpose of the study was to find out how teachers use questions in a classroom discourse to scaffold learners thinking and help learners to construct scientific knowledge.

The study adopted the constructivist approach, and the findings recommended potential translating research with insights into practical advice for teachers regarding tactical moves in classroom discourse, and provided guidance for teachers to increase their repertoire of questioning skills. Therefore, if teachers embed formative assessment in a form of questioning, various aspects must be considered such as time, nature of the task, including questions from various levels, learners' thinking capability as well as lesson outcomes.

Despite the gaps and challenges discussed above by different scholars (Chin, 2006; Myhill & Dunkin, 2007; Florez & Sammons, 2013), the Assessment Reform Group (ARG) by Broadfoots, Daugherty, Gardner and Herlen (2002) in the United Kingdom recommends key elements that teachers may consider when using questioning during formative assessment to be effective to learners. They include increasing waiting time for learners to think and answer appropriately, employing quality questions that are of great use to learners, encouraging learners to use high order thinking skills to answer questions and purposely create a non-threatening environment where learners are free to share their ideas and expose their misconceptions without fear of giving the wrong answers.

The idea of a question is to enhance learners' opportunities to discuss misconceptions and clarify them while formative assessment is in place, thus assisting learners to develop a scientifically more accurate and deeper understanding. These recommendations have the potential to improve and strengthen science teachers' formative assessment classroom practices.

### Feedback

Apart from the above-mentioned strategies with their positive significance and limitations, various literature reviewed in this section reveals that feedback is seen as the 'heart' and the primary component that has the strongest influence on learning as teachers embed formative assessment in their classroom practices. Rushton (2005) defined feedback as a method used by teachers in the provision of information about the existing gap between the actual and desired level of performance. Similarly, Hattie (2009) defines feedback as information about the existing 'gap' between the actual level and the reference level of performance, stressing that information is only feedback if it is used to alter the gap.

In addition, Florez and Sammons (2013) state that feedback can be informative or descriptive, where informative feedback is singular without any reference to criteria or any commentary, while descriptive refers to specific information, in the form of written comments or verbal conversation for learners to understand what they need to do in order to improve. Thus descriptive feedback is the one that is commonly used by teachers when embedding formative assessment.

Hattie and Temperley (2007) explained the fundamental aspects of feedback, they include improving learners' learning, changing traditional classroom practices, clarifying learning criteria and improving learners' achievements. This entails that feedback must focus on the process, not the natural ability, thus praising and reinforcing an effort is better than praising the intelligence. The former increases the intrinsic motivation in learners. Moreover, Hattie (2009) contends that feedback possesses two significant components; that is, the teacher as a provider of feedback and the learner as a receiver of feedback.

The feedback provider is the teacher who provides feedback after carefully analysing learners' tasks or questions while the feedback receiver refers to learners receiving the feedback from the teacher, making meaning out of it. Feedback has been regarded as a critical strategy in various research studies as it allows learners to check where they are with regard to their level of understanding. For instance, when the teacher in a science classroom is delivering a lesson on the electric circuit, the teacher might ask learners to give their scientific understanding of what happens if one keeps on adding light bulbs in the circuit. Learners provide their understanding characterised by misconceptions and misunderstanding of scientific operations. After the learners' explanations, the teacher will then provide the feedback that if you increase the number of bulbs in a circuit, the light becomes less bright as it affects the resistance in a circuit. However, the teacher can construct the circuit together with the learners to validate the explanation of the effect of adding light bulbs in a circuit because science is about practical demonstration; in that way the scientific understanding will be enhanced because of feedback accompanied by practical demonstration.

**Peer Assessment**

Real understanding and learning in a science classroom require not only to grasp the scientific concepts but also the establishment of meaningful and fruitful links to bring scientific concepts into a coherent whole through peer assessment. Bound (2001) defined peer assessment as learners' learning from and with each other in both formal and informal ways. Notably, peer assessment can be used interchangeably with the concept of peer learning within the context of formative assessment.

Various research studies encourage the usage of peer assessment while the teacher embeds formative assessment in a science classroom. Spiller (2012) posits that peer assessment naturally moves learning from being teacher-centred to being learner-centred, thus it increases the level of trust and engagement among learners because this strategy occurs through collaboration; furthermore, the mode of learning through participation, metacognitive and reasonability is being enhanced. This implies that learners in peer assessment become assessors within the context of participation in the classroom practices.

If peer assessment and collaboration are used while the teacher embeds formative assessment, the nature of assessment activities must be aligned such that peer learning is promoted. Stribos and Sluijsmans (2010) pointed out two factors that could render quality outcomes of peer assessment in a classroom setting appropriate and incredible. They further allude that once those factors are carefully considered, learners will be able to make a decision about their peers' work and decide what constitutes good work; this can be done anonymously, randomly or in a group, thus making learning from other learners. The study by Carlie and Jordan (2005) mentioned some benefits that peer assessment brings while the lesson is taking place during classroom practice. Peer assessment benefits teachers as it reduces their marking load and allows them to devote more time to other aspects of teaching and learning; it also frees up time for teachers to enable them to manage the peer assessment process more efficiently and effectively while it is in place. However, if science teachers can adopt peer assessment during instruction, naïve misconceptions and ideas in learners can be identified and corrected collectively.

The application of peer assessment in a classroom practice adopts the socio-cultural approach by Vygotsky as learners are being observed while they are interacting with each other, raising and support their ideas about the task. On the other hand, the teacher acts as a facilitator of learning in a form of Zone of Proximal Development, scaffolding and taking the role as the More Knowledgeable Other. In agreement with a teacher as a facilitator, Wride (2017) emphasised the three stages a teacher should consider adopting to successfully facilitate peer assessment in a classroom practice. Firstly, the teacher should prepare peer learning that brings exposure to learners in such a way that the peer assessment avoids conflict, develops good communication skills, encourages active participation as well as giving and receiving feedback.

Secondly, the teacher should design clear peer learning activities, particularly by grouping learners in small numbers and maintaining discipline among the groups. Lastly, the teacher should reflect on the skills gained from peer learning; this may include exploring learners' sense of working with one another either in a group or with their peers. By adopting the three above mentioned stages, the science teacher can easily activate the desired learning objectives when embedding formative assessment in a science classroom in a form of peer assessment.

Every teaching strategy has its advantages and disadvantages, apart from the benefits and important elements of employing peer assessment discussed above. The study conducted by Bijami, Kashef and Nejad (2013) in Malaysia reveals that peer assessment seems to be challenging in several ways. Challenges may include that the peers can comment on the surface of the activities and with errors and may give advice that does not help other learners. It seems to be challenging that most learners prefer to be assessed and judged by the teacher because they believe that the teacher is the only person qualified to make that judgement about their learning, thus the purpose of employing peer assessment from this view seems to be dire and futile. Saito and Fujita (2004) reported that there are many studies that indicate the biases associated with peer assessment, including friendship, reference and purpose (development against grading); learners can judge the work of their peers without following criteria due to friendship. Nonetheless, research indicates that peer assessment can benefit learners if it is correctly implemented because learners develop critical and analytical skills if they are being afforded an opportunity to take responsibility for their learning and are effectively guided towards doing so.

**The formative use of summative assessment**

The terms summative and formative assessment are fundamental to understanding assessment in a classroom situation. Summative assessment emphasises summing up or summarising learners' achievement; that may occur through formal tests, for instance, with the purpose of grading learners (Shavelson, 2008). While on the hand, formative assessment is centred on active feedback that assists learners' learning such as class discussion, peer assessment and questioning (Black & Wiliam, 2011). In this decade of uncertainty in the world, such as now, the South African education system has moved from traditional system and heavily relied on the modernised system to prepare learners to meet unknown future challenges, thus the instructional leaders (teachers) are expected to have a clear understanding of integrating formative assessment with summative assessment.

The formative use of summative assessment occurs within the classroom where the teacher uses summative results as part of formative assessment to help learners to understand very well what is needed of them. Florez and Sammon (2013) revealed that this specific type of strategy does enhance learners when the teachers embed formative assessment. The results also show that learners that are taught under this strategy have improved their learning, and judging their achievement at a specific point in time shows great improvement. Although lots of research studies in assessment literature today aim at delineating the differences between summative and formative assessment, Bell and Cowie (2001) agreed that the very same tests used for a summative purpose can also be used for a formative purpose as well. Scholars (Burke, 2010; Garrison & Ehringhaus, 2011) assert that many teachers think that summative assessment mainly occurs too late in the learning process to make a judgement about learner's learning, but research does not reflect these views. Black and Wiliam (2011) in their study adjusted teacher's thoughts on using summative and formative assessment to support each other's instruction in the classroom context because teachers were ignorant and struggled to separate the two types of assessment. However, research evidence (William, 2011; Florez & Sammon, 2013) showed that teachers found it useful to use summative assessment for formative purposes.

Although the formative use of summative assessment seems to have positive outcomes in teaching and learning within the classroom practices, some studies suggest challenges encountered by teachers as they embed formative assessment using this strategy. Burket (2016) conducted a study with 50 education lecturers at an English University, and he suggested that due to the inconsistencies in the literature, lecturers struggled to understand the relationship between summative and formative assessment. The study used survey questionnaires to collect data and findings revealed that lecturers were not sure about the relationship between formative assessment on grading and the role of summative assessment when it is not a final summation.

The study concluded that there is a need to reconcile between formative and summative assessments so that both are mutually supportive in the implementation of formative assessment; therefore, further research is still needed due to a literature gap. However, it must be emphasised that the formative use of summative assessment must be guided by certain aspects such as a clear understanding that the two strategies can be used simultaneously, thus the teachers need a thorough understanding on how and when to use it. Therefore, there is a need for professional development so that teachers may improve their classroom practice.

## 2.5 DEVELOPING FORMATIVE ASSESSMENT PRACTICES THROUGH PROFESSIONAL DEVELOPMENT

Formative assessment is anchored in one's classroom practice and is characterised by the modification and adaptation of teaching practices to meet the individual needs of learners in the social setting of the classroom. Although formative assessment is regarded as a drive-through to the success of learners, teachers as the role players should be acquainted with vast knowledge on how to effectively embed formative assessment in their classroom practices, thus the need for improving teachers' formative assessment practices through continuous professional development. Ayala (2005) conducted a qualitative study in Montreal, Canada focussing on how teachers embed formative assessment. His study recommended that teachers' skills of embedding formative assessment in their classroom practice are enhanced through professional teacher development.

Furthermore, Lyon, Wylie, Brockway and Mavronikolas (2018) conducted a qualitative study in the United States in Princeton, purposively sampling 82 Mathematics and Science teachers from different high schools; their findings resonate with Ayala (2005) as they contend that professional teacher development has a positive impact on the manner in which teachers embed formative assessment in a science classroom. Their findings indicate that professional development increased the teachers' use of formative assessment and assisted them in understanding the breadth and complexity of its nature and how it may be used effectively in stimulating learners' understanding.

Similarly, Webb (2009) confirms that the rationale behind emphasising professional teacher development programmes is to change and channel teachers to create opportunities for them to reconceptualise their instructional goals, re-evaluate the extent to which formative assessment practices support those goals and help them to develop a 'designer-eye' for embedding, adopting and designing assessment to enhance learners' understanding.

Countries such as America strongly believe that professional development does take place within the science classroom in a form of classroom teacher observation. Israel (2017), an independent American writer, explained that classroom teacher observation must serve as a vehicle for professional development rather than performance evaluation. When embedding formative assessment, teacher observation can yield its greatest benefit when used as a means of sharing instructional techniques to embed formative assessment. Consequently, the National Staff Development Council (NSDC) in the United States posit that to be observed when embedding formative assessment can rattle any teacher's nerves. However, being observed as a teacher is a model that supports professional development and the positive benefit of it makes teaching a public rather than a private event. The Executive Director of NSDC, Dennis Sparks (2019) states that it is awkward to have your professional development practice scrutinised by a colleague. He further proposes that a teacher needs to have some level of trust in the observer and that trust must be motivated bythe fact that the observer is helping to strengthen the professional development of the teacher's formative assessment in his/her classroom practice, instead of blaming the teacher.

Iqbal (2017) is of the view that before embedding formative assessment in science classroom practices, teacher's first need to be well equipped with advanced knowledge and understanding regarding formative assessment functionality and roles of teachers and learners on the implementation, thus this can be done through professional teacher development. The findings of the study by Iqbal (2017) contend that to increase teachers' understanding and skills for the purpose of functionality, science teachers must be frequently engaged in professional development programmes.

Zarrow (2020) contend that when engaging to improve the implementation of formative assessment, the following elements need to be adopted: ensuring that School Management Team (SMT) advocate and support teachers as a form of professional development, building a community of trust among teachers especially when the observation is in place and organising phase meetings, coaching sessions and follow-up discussions.

In their work titled *'Implementing curriculum embedded formative assessment in primary school science classroom'*, Honderich, Hertel, Adl-Amini and Kliema (2016) conducted a mixed-method study at Heidelberg in Germany with a sample of 28 primary school teachers from 18 schools to identify the impact that a teacher development programme has on the implementation of formative assessment in a science classroom. Participants were divided into two groups, namely the treatment group and the control group; each group received five professional development activities on the aspect of density. This aspect refers to the comparison of the amount of matter an object has to its volume; if the object has a high volume then the density is high, but if the object has little volume, the density is to be little as well. Through that professional development, teachers were able to introduce this concept in a form of an experiment where a practical demonstration occurred. The teacher begins by pouring water into any container and uses two objects, plank and the stone. He uses the information discovered from their professional development training activities to explain the purpose of the practical. Thereafter, learners observe the behaviour of the object - if it sinks it means that the density of that object is higher compared to the density of water, whilst the object that floats can be taken as having density compared to the density of water. Therefore, teachers understood through practical learning and experiments that learners can develop meaningful understanding, thus strengthening their conceptual development of scientific concepts which they generally struggle with.

Even though the research evidence shows that professional development helps teachers to unpack the scientific concepts and understanding effectively in their classroom practices while formative assessment is in place, the nature, quality, design, relevance, timing and quantity of professional development are also critical. Santo and Darling-Hammond (2008) conducted their study in the United States with an aim to improve teachers' assessment through professional development in collaboration with National Board Certification.

Even though the study was not focusing on science education specifically, the findings of the study reveal that teachers' voices in professional development must also be taken into consideration as they are the agents who implement the lessons in the classroom and it is them who encounter challenges while conducting lessons. Santo and Darling-Hammond also stated that professional development programmes must define the standards that have potential in effectively changing practices and should offer a clear vision on the purpose of the programme and should provide differentiated training needs for teachers.

Thus, Santo and Darling-Hammond (2008) recommend that professional development programmes must offer teachers opportunities to engage in reflective analysis of their teaching practices using rigorous standards as tools for critique. Moreover, the National Board Certification process allows for professional development to be a personal process, especially for teachers such that they can capitalise on reflective opportunities to hypothesise on what is working well for them and what is not working as the implementers of the assessment. Significantly, they stress that teachers have voices which are necessary for them to improve their daily classroom practice rather than being asked to adopt foreign practices which are disconnected and irrelevant to their daily context. Thus, Santo and Darling-Hammond strongly suggest that future research is still needed that should examine the kind of teaching conditions and support necessary for teachers to sustain practices that are learned during the intense professional development experience. Therefore, this study intends to make such a contribution from a science perspective.

## 2.6 CONTEXTUALISING PHYSICAL SCIENCE FORMATIVE ASSESSMENT IN THE SOUTH AFRICAN CURRICULUM

The broad aim of the South African National Department of Basic Education (DBE) is to develop, maintain and support a South African education system for this 21st century (Department of Basic Education, 2011). The vision of the DBE curriculum is that all learners should be afforded equal opportunities to learn. The introduction of the Curriculum and Assessment Policy Statement (CAPS) envisions closing the gap between the poor schools and well-resourced counterparts, identifying and addressing challenges to teaching and learning (DBE, 2011).

### 2.6.1 Physical Sciences Curriculum and Assessment Policy Statement (CAPS) Grade 10-12

The Physical Sciences curriculum is part of the teaching and learning activity as it is goal-oriented. The goals prescribed in the document seeks to provide intended outcomes. According to the Curriculum and Assessment Policy Statement (Department of Basic Education, 2011), Physical Sciences is the subject of investigating physical and chemical phenomena and this is done through the process of inquiry, application of scientific models, principles and laws to explain or predict any events in the physical environment. Furthermore, the DBE (2011) states that this subject plays an incredible role in the lives of all South Africans as it produces scientific and technological developers who are highly needed for the country's economic growth and the social wellbeing of its people. All the scientific and technological knowledge that learners obtain in Physical Sciences shall possess the following aspects: a social transformation that ensures that imbalances of the past are re-addressed and learners should receive equal learning opportunities to have effectively transformed; active and critical learning so that there is no rote learning in the classroom practices; progression so that the content and context that learners receive reflect advancement patterns as learners progress with grades and strengthen knowledge; and, lastly, the curriculum must evince credibility, quality and efficiency by providing quality education that is globally recognised in the field of Science education. Thus, the need for effective integration of formative assessment in a science classroom.

Physical Science promotes credible knowledge and skills that enable learners to identify and solve problems and take good decisions using critical and creative skills. According to the DBE (2011), Physical Sciences should equip and prepare learners with investigating skills related to physical and chemical phenomena so that they become future specialists, future employers, and socio-economic development and environmental managers. The CAPS document for Grade 10-12 Physical Sciences outlines several practical and experiments activities for formal and informal assessment that must be integrated with science theory to broaden the use of scientific concepts being dealt with in the FET phase.

Also, the CAPS document for Physical Sciences (Department of Basic Education, 2011) specifies the teaching time allocation for Grade 10, which is four hours per week. However, the time allocated must surely cover the teaching content, scientific concepts and skills as prescribed in the document, considering that learners doing Physical Sciences have many deep-rooted misconceptions and preconceptions that would have to be effectively addressed through formative assessment instruction and practice-orientated activities.

According to the DBE (2011), assessment is the process that measures an individual learner's attainment of knowledge in the form of content, concepts and skills in Physical Sciences. This is attained by collecting, analysing and interpreting the information obtained to enable the teacher to make valid and reliable judgements about learner's learning, inform learners about their strengths, weaknesses and progress so as to assist teachers, parents and concerned stakeholders in making decisions about learners' learning and their progress. The CAPS also stipulates guidelines on the number of assessment activities that must be given to learners in Physical Sciences to enrich and improve their performance. However, assessment activities should be both informal and formal; the informal activities are used for daily monitoring of learners' progress through formative assessment (Department of Basic Education, 2011).

Through Physical Sciences informal tasks, learners should be given at least two problem-solving exercises frequently; these informal tasks should collectively cover all the cognitive levels ranging from remembering to creating. This is done through homework, classwork, group work, practical investigations, experiments or even informal tests. Informal assessment should be structured in such a way that it enhances learners understanding and should be useful for formal assessment in the programme of assessment. The DBE also stresses that informal assessment activities within the classroom practice must be used to provide feedback to learners.

Hence they inform the teacher about where and how learners are learning in order for the teacher to adjust his/her teaching plan. Teachers and learners can mark those informal assessments, and after marking them collectively, learners must be made aware of their mistakes or errors thus enhancing their learning. Whilst informal assessment is in place, it should promote peer and self-assessment as it makes learners actively engaged in the learning process to improve their performance. It also encourages the learners to take initiative of their learning (Department of Basic Education, 2011). Learners in Physical Science should be motivated to participate in classroom activities without fear hence the classroom atmosphere should allow learners to explore, engage and acquire relevant skills.

Formative assessment (also referred to as assessment of learning) activities are conducted to address the needs of learners and check the effectiveness and efficiency of the learning method. On the other hand, formal tasks are subjected to moderation for quality assurance and ensuring quality standards for grading purpose most of the time. Through formative assessment, teachers do a systematic evaluation of how learners are doing and progressing in Physical Sciences (Department of Basic Education, 2011). Although Physical Sciences is the subject of scientific inquiry, scientific laws and calculations, it must develop language skills such as reading and writing; science teachers should be aware that they are also involved in teaching language across the curriculum.

However, teachers should provide learners with ample opportunities to develop and improve their skills within the context of learning sciences, especially learners for whom the Language of Learning and Teaching (LoLT) is not their home language. Therefore, Grade 10 learners must be afforded necessary opportunities to read scientific texts, reports in the laboratory or after the experiments; they can even write short essays that form part of formative assessment. In the light of the foregoing, the implementation of formative assessment has the potential of effectively promoting positive learning objectives. Although the Curriculum and Assessment Policy Statement clearly outlines the purpose of formative assessment in the science classroom, how teachers conceptualise, operationalise, integrate and embed formative assessment into the classroom practice makes a considerate difference in the teaching and learning process.

## 2.7 SCIENCE TEACHER'S CHALLENGES ON THE USE OF ASSESSMENT FOR LEARNING IN THEIR CLASSROOM PRACTICE

Formative assessment has benefits attainable through a set practices as prescribed in the Curriculum and Assessment Policy Statement (CAPS, 2011); however, its benefits are still not adequately conceptualised, operationalised and effectively implemented by teachers as they experience challenges. Stewart (2012) argued that what brings about the underutilisation of formative assessment in the classroom practices may be that teachers lack knowledge and skills to apply it in their practices. Moreover, Stewart posits that when the term 'assessment' is generally used, teachers think of formal tests and standardised examination for grading purpose, thus, particularly from this point of view, formative assessment might be considered as responsive teaching.

Similarly, a qualitative study was conducted by Crossman (2004) in Australia to identify the factors influencing the assessment perceptions of training teachers; the findings contend that when an assessment is delivered in the classroom, the main focus is on the final examination, and not on formative assessment. Thus, their findings indicate that teachers' main concern is on 'knowing' rather than 'understanding', whereas formative assessment is underpinned by understanding.

Other scholars (Heitink, Van der Kleij, Veldkamp, Schildkamp & Kippers, 2016) also stress the need for teachers to possess adequate knowledge and relevant skills so that they have the potential to analyse and interpret evidence from formative assessment activities given to learners during their classroom practice. In addition, Hoogland, Schildkamp, Van der Kleij, Heitink, Kippers, Veldkamp and Dijkstra (2016) advocates that if teachers have deep knowledge and the necessary skills to adapt instruction, they will be able to facilitate instructional practices most suited to satisfy their learners' needs in their classroom practice, thus bridging the gap between current and desired learning outcomes - which is critical during formative assessment practice.

Research evidence shows that although many studies have been conducted on formative assessment with regard to its benefits on harnessing learners' understanding, however, they also highlight the challenges that teachers experience as formative assessment practice is a rather complex process. According to Turkaj and Dreshaj (2017), teachers find it difficult to embed formative assessment in their classroom practices; they are unsure of the specific areas to explore. School management teams stipulate requirements for attaining quality results by focusing on summative assessment in the standardised national examination; this results in teachers being uncertain whether to assist learners to understand the concepts while learning is taking place, which is the focus of formative assessment, or teach for the examination.

However, Turkaj and Dreshaj alluded that teachers are prone to formative assessment tests designed mainly to help in facilitating the achievement of excellent results. This practice seems to be perpetuated by the pressure from school management, parents and politicians of promoting the attainment of good results. Bennett (2011) also reveals that accountability is another challenge encountered by teachers and it is regarded as an external challenge. It negatively impacts the implementation of formative assessment during classroom practices because at the end of each term and also at the end of the year, teachers ultimately need to account to the parents about the performance of learners for grading purposes. Due to eventuality, teachers eliminate some formative aspects in order to cover the examinable work. On the other hand, Vingsle (2014) clarifies the internal challenges that teachers face on a daily basis. Teachers grapple with the complexity of formative assessment as an instructional method as they have to use various strategies to plan their lessons. In support of the internal challenge posited by Vingsle, other scholars previously (DeLuca, Luu, Sun & Klinger, 2012) also emphasised that another internal challenge teachers encounter in their practices is the misunderstanding of the concept of 'formative assessment.' For instance, teachers who are not aware of the connection between summative and formative assessment cannot use this information to capacitate learners in such a way that they become owners of their learning in most assessment tasks; instead, they teach for summative purposes only and not for understanding.

Dube and Jita (2018) conducted a qualitative study in South Africa and Zimbabwe with 25 participants using purposeful sampling and snowballing, and adopting interviews and focus group discussions. The aim of the study was to identify trajectories on implementing assessment in rural-based South African and Zimbabwean schools. The findings of their study revealed the factors that hinder the implementation of assessment were lack of resources and inadequate teacher preparation (professional development); they further elaborate that science teachers embed formative assessment with limited resources, thus the learners' understanding cannot be enhanced because learners are supposed to do experiments using very limited resources.

Science teachers in South Africa and Zimbabwe believe that an inadequate supply of learning resources makes formative assessment practices to be challenging and limited. Teachers who participated in the study by Dube and Jita, both South African and Zimbabwean teachers, indicated that the professional development they had received did not satisfy their needs and should to be differentiated and tailor-made to suit their classroom contexts. Santo and Darling-Hammond (2008) point out that teachers' skills in assessing learners' progress also depend on how deeply teachers know the assessment strategies and how well they understand and interpret the progress of learners in their engagement and written work. They stress that nothing can fully compensate for the weakness of teachers who lack the skills and knowledge needed to help learners to master the formative assessment activities other than quality and well planned professional teacher development that allows collaboration from teachers and practice-oriented engagement relevant to their context. Each school has its own leadership style used by the school management team (SMT). A study conducted by Boonruang (2015) reveals that science teachers who are responsible for STEM subjects (Science, Technology, Engineering and Mathematics) encounter a challenge when implementing the formative assessment under the 'Top-Down Mechanism' management style especially for teachers.

The Top-Down approach is undesirable because it limits teachers' innovation and involvement as people who are responsible for executing formative assessment in their classroom practice, while the management at the top usually takes decisions about learners' learning and require teachers to adopt them without considering the problems that exist in classroom practices. While the involvement of teachers from the very onset might also be a challenge, it can allow teachers to voice their concerns. Boonruang (2015) concluded by recommending the Bottom-Up mechanism, especially to STEM subject teachers.

As a result of the above-explained challenges that teachers encounter in their classroom practices, it is significant that teachers should be equipped with a thorough understanding of the concepts of formative assessment and its applicability. However, for teachers to effectively implement formative assessment, they should work hand in hand with parents and school management teams to avoid unnecessary pressure. Furthermore, the assessment should not solely focus on grades instead, it must enhance understanding. As many studies clearly outline the challenges experienced by teachers, it is evident that a gap exists regarding the need for continuous professional development interventions specifically related to the pedagogy of formative assessment in classroom practice.

## 2.8 CHAPTER SUMMARY

This chapter discussed literature in line with the objectives of the study. The literature reviewed was guided by the objectives and theoretical framework underpinning the study and it contributes to the critical strategies science teachers may consider adopting to effectively embed formative assessment. The literature also delved into the challenges faced by teachers when implementing assessment for learning, particularly in secondary science education. Various international and national studies across the length and the breadth of the globe have provided different perspectives on embedding formative assessment in science classroom practices as well as offered key elements that should be carefully considered during the process of assessment for learning. The contextualisation of formative assessment in the South African curriculum from a Physical Sciences perspective was reviewed and its curriculum implications were outlined according to the Curriculum and Assessment Policy Statement (CAPS). The next chapter provides the methodology and design of the study.

# CHAPTER THREE

# RESEARCH DESIGN AND METHODOLOGY

## 3.1. INTRODUCTION

This study sought to explore Grade 10 Physical Science teachers' perspectives on embedding formative assessment in a Physical Science classroom in Inkosi Sambane Circuit Schools, with the view to promote the inclusion of best assessment practices within a science context. The previous chapter outlined the theoretical framework which underpinned this study. It also included the review of literature which focussed on key elements and strategies of embedding formative assessment in classroom practice from the perspective of science education and highlighted the critical challenges teachers encounter during this process.

This chapter explains in detailed the description of the research methodology employed in this study. Firstly, the chapter outlines and describes the research design and research paradigm. Secondly, the target population, sampling procedures and data collection procedures with its instruments are clearly explained as well. Thirdly, the study delves into trustworthiness indicators such as credibility, transferability, dependability and confirmability and these elements are discussed to ensure that the quality of the study is maintained.

Fourthly, intended contribution to the body of knowledge and ethical and safety considerations are discussed. Lastly, the limitations of the study are outlined; thereafter the chapter concludes with the chapter summary. The principal objective of this study was to find answers to the following research questions:

- What are the Grade 10 Physical Sciences teachers' perspectives on embedding formative assessment in their classroom practices?
- How do Grade 10 Physical Sciences teachers embed formative assessment in their classroom practices?
- What are the challenges that Grade 10 Physical Sciences teachers' encounter during embedding formative assessment in their classroom practices?
- What classroom support and guidance are available to Grade 10 Physical Sciences teachers in embedding formative assessment in their classroom practices?

## 3.2. RESEARCH DESIGN

It is crucial to provide insights into ‘how’ this study was conducted using a particular research design methodology. Research design is a blueprint on how an individual intends conducting research (Kumar, 2019). Furthermore, the research design is a framework of methods and techniques chosen by the researcher to combine various components of research so that the research problem is effectively handled and monitored (Kumar, 2019).

A qualitative approach was deemed appropriate and followed in this study because the researcher intended to obtain an in-depth understanding of how Grade 10 Physical Sciences teachers embed formative assessment in their classroom practices. According to McMillan and Schumacher (2010), qualitative research is meant to be descriptive and interpretative. The study aimed at shedding light from multiple perspectives in terms of exploring as well as ascertaining how Physical Science teachers embed formative assessment. Grade 10 was chosen because this grade is the entrance into the further education and training phase. In this grade learners are expected to grasp basic knowledge about scientific skills, reasoning, adequate conceptual development and correct both misconceptions and preconceptions through formative assessment.

Within the qualitative approach, the researcher decided to adopt a case study design for this study as he intended to examine the perspectives and practices of participants (teachers) involved in this study since the case study examines practices over time and accommodates for an in depth analysis of data collected (MacMillan & Schumacher, 2010). Employing the case study to this research ensured that the objectives were enhanced. However, Kumar (2019) is of the view that to obtain reliable and valid data through a case study, a multiple case study design can be used such as gathering information through observation and focus group interviews. Similarly, Yin (2011) regards a case study as an empirical inquiry about a contemporary phenomenon.

Therefore, the researcher considered the multiple case study to be appropriate for this study; the rationale for considering and selecting a multiple case study was that it enabled the researcher to use data from research participants (teachers) with in-depth contextual descriptions and comments on their experiences and perspectives towards embedding formative assessment in Grade 10 Physical Sciences and also observed their classroom practices to obtain a better, trustworthy and transferable insight.

## 3.3. RESEARCH PARADIGM

The researcher employed an interpretivist research paradigm guided by qualitative design to investigate the research problem. Creswell (2011) and De Vos, Strydom, Fouche and Delport (2011) posited that the interpretivist paradigm is a combination of constructivism and social constructivism. Furthermore, Creswell (2011) emphasised the main reason behind interpretivism; its goal is to rely as much as possible on the participants' views of the situation that is being studied. In concurrence, Myers (2009) stated that the interpretive paradigm is underpinned by observation and interpretation, thus to observe is to collect information about how things happen in a particular event, situation or an episode that is investigated. On the other hand, interpreting is about drawing relevant meaning from the inference and make a judgement about the information and abstract pattern, which is most suited to this study thus I sought to adopt the interpretivist paradigm.

In agreement with Creswell (2011), the study by Reeves and Hedberg (2003) posited that the 'interpretivist' paradigm in a research study stresses the importance of putting analysis into context; they concluded their argument by emphasising that this paradigm is concerned with understanding and knowing the world in relation to the subjective experience of an individual. The researcher in this study, through the set objectives, sought to ascertain how Physical Science teachers embed formative assessment, the challenges they experience and the kind of support and guidance that is available to them; therefore, the interpretivist paradigm was deemed most suitable to this study. Crewell (2011) emphasises that in a study that is underpinned by the interpretivist paradigm, the research questions must be broad and general so that the participants can construct meaningful ideas about the situation that is being studied. This was also considered relevant in this study.

### 3.4. TARGET POPULATION AND SAMPLING PROCEDURES

A population is a whole group of people or things that have one more similar elements in common from which the data can be collected. According to this study, the target population consisted of teachers who taught Physical sciences in Grade 10, specifically at Inkosi Sambane circuit schools in KwaZulu Natal. Creswell (2011) emphasised that before sampling is done on a population, various aspects must be considered such as sampling method and sample size - especially when the study is qualitative in nature., Thus this section addresses those aspects.

Sampling is the selection of participants in the study. Kumar (2019) defines sampling in qualitative research as designed to gain in-depth knowledge and understanding about the situation, event or episode to know as much as possible; he further alludes that the goal of sampling in qualitative research is not just to randomly select participants, instead, participants must be selected such that they can provide the researcher with plenty, detailed and reliable information that the researcher is looking for. Similarly, De Vos, Strydom, Fouche and Delport (2011) defined a sample as a limited or small representation of the whole population.

Patton (2002) clarifies that there is no fixed principle when it comes to sampling size in a qualitative study. However, it is crucial to maintain a scale that shall best represent the population. For instance, the sample size should be adequate and sufficient enough to produce fair, reliable and valid outcomes about the event or episode, and this was taken into consideration in this study. Thus all these crucial elements were considered in the sampling selection for this study. The study aimed at exploring teachers' perspectives on embedding formative assessment in Grade 10 Physical Sciences at the Inkosi Sambane circuit, therefore, the researcher purposively selected the participants and this sampling is judgmental, selective and subjective.

Kumar (2019) defines purposive sampling as 'whereby the researcher chooses participants due to the extensive knowledge about an episode, an event or a situation of the interest to the researcher.' The rationale for the researcher specifically selecting the purposive sampling technique was that the selected participants offered an in-depth analysis of the information required and possessed an appropriate level of knowledge and understanding about the phenomena in the study.

In addition, it was useful in this study because all the objectives were achieved. Due to the nature of the research questions, the purposive sampling approach adequately addressed all four research questions.

The study was conducted in the UMkhanyakude district in the Northern part of the province of KwaZulu-Natal, which is one of the nine provinces in South Africa. The researcher selected the Inkosi Sambane Circuit which comprises twelve high schools offering Physical Sciences. Thus, the researcher selected those twelve high schools as the sample. The researcher purposively selected one Grade 10 Physical Sciences teacher per school which makes up a total of twelve teachers as the participants for the semi-structured focus group interviews and non-participant observations as methods of data collection.

The reasons for selecting Grade 10 include the fact that in Grade 10 Science teachers are expected to lay the good foundation by following all the necessary steps of assessing learners. Also the selection of the participants was based on the assumption that they were most likely to generate useful data that would answer all research questions. However, the selected schools were rural-based schools and the intention was to find relevant strategies that may assist and support teachers when embedding formative assessment to improve the quality of learner achievement in Physical Sciences.

## 3.5. DESCRIPTION OF DATA COLLECTION PROCEDURES

Kumar (2019) posits that there are two approaches to classifying and gathering data, that is, primary and secondary data. Primary data collection is the information that is collected by a researcher, while secondary data is the data readily available to be used. The researcher used primary data approach in this study to collect information from the participants. A semi-structured focus group interview schedule and non-participant observation schedule were considered as primary data approaches, thus the researcher used them to collect the data as most suitable for the qualitative approach.

### 3.5.1. Semi-structured focus group interviews

Kumar (2019) asserts that semi-structured focus group interviews are extremely useful in exploring intensively and extensively and digging deeper into a situation, phenomenon, issue or problem. Scholars (Gill, Stewart, Treasure & Chadwick, 2008) emphasised the implications of employing semi-structured focus group interviews when collecting data; this data collection method consists of several questions that help a researcher to understand the areas to be explored. It also allows both the researcher and participants to diverge in order to pursue an idea, response or even an understanding in a more detailed and precise manner. However, Gill et al., (2008) posited that the findings in semi-structured focus group interviews are established primarily through follow up questions; for instance, the researcher may probe interesting or important response with a follow-up question, such as ‘can you elaborate a bit more about your response.

In addition, semi-structured focus group interviews have a certain purpose when adopted in a research study. The primary purpose of this method is to explore the views, experiences, beliefs and motivation of certain individuals based on a specific aspect; for instance, this study opted semi-structured focus group interviews because the researcher sought to explore views, understanding, experiences and beliefs on how teachers embed formative assessment in their classroom practice at a high school level. This qualitative data collection method provided the researcher with a deep understanding of the phenomenon in a social setting; therefore, semi-structured focus group interviews are most appropriate where details and in-depth insights are required from the participants, thus the need to use this instrument in this study.

Based on the afore-mentioned implications and importance of the semi-structured focus group interviews, the researcher specifically decided to employ this method in this study due to its advantages and relevance to this study. The semi-structured focus group interviews gave both the researcher and participants as much flexibility and relaxation as possible, thus allowing the researcher to ask probing questions and make follow ups on the very interesting points and avenues that emerged which were of relevance to the study while the session was taking place (De Vos et al.,2011). There were three sessions of interviews, each focus group consisted of four teachers specifically those who were responsible for teaching Physical Sciences at Grade 10 in the FET phase from each of the twelve sampled schools. Due to the global pandemic COVID 19, all the necessary health protocols were observed while the semi-structured focus group interviews were in place, which included maintaining of social distance, using face masks throughout the sessions and sanitising before and after the session.

The semi-structured focus group interviews schedule addressed objectives 1, 2, 3 and 4 which were to explore Grade 10 Physical Sciences teachers' perspectives on embedding formative assessment in their classroom practices, ascertain how they embed formative assessment in their classroom practices, determine the challenges that these teachers encounter during the process and identify the classroom support and guidance that is available to Grade 10 Physical Sciences teachers in embedding formative assessment in their classroom practice. Relevant questions were designed and clustered accordingly by the researcher to address these objectives (see Appendix A).

Informed consent declaration forms were issued to participating teachers for completion and signing before the actual interview process began (see Appendix E). The researcher then informed all the participants that the information provided would be treated with confidentiality and anonymity; pseudonyms would be used and their names would not appear anywhere thus they must feel free in answering questions. In addition, the researcher explained to participants that participation in the study was voluntary and that each participant may withdraw if they are willing to do so. The researcher then carried out the interviews on the agreed scheduled dates using a tape recorder and a smartphone to voice-record. The proceedings of the joint interview and the sitting plan adhered to the social distancing of 1,5 metres amongst participants and made use of a well-ventilated room due to the pandemic. The time-frame for each interview session was set to range from 45-60 minutes, however, it depended on the participants being interviewed or the depth of information they were willing to share with a researcher.

Each of the focus groups was given a sheet with the questions to go through before the commencement of the semi-structured focus group interviews (see Appendix A) and were provided with an opportunity for clarity before the interview process began. To ensure that participants spoke freely without fear, the researcher used pseudonyms (teacher 1 thus T1, T2, T3 – T12) to ensure confidentiality and anonymity. Interviews were recorded, with the participants’ permission, using a smartphone and tape recorder. The whole interview process took almost an hour per group. All the interviews were transcribed verbatim using themes.

### 3.5.2. Non-participant observations

According to Kumar (2019), “Non-participant observation is when a researcher does not get involved in the activities of the group but remain a passive observer, watching and listening to the activities and drawing conclusions’’. Similarly, Liu and Maitlis (2010) define non-participant observation as a data collection method that involves observing participants without actively taking part or participating in the activities or events that they are doing. In essence, this data collection method is used to understand the event or phenomenon in a social setting whilst the researcher remains separate from the activities or events being observed. In this study, the non-participant observation allowed the researcher to see what was happening in the classroom, thus triangulating and aligning their classroom practice with what was mentioned during the semi-structured interviews to determine it whether it corroborated or not.

However, Liu and Maitlis (2010) cautioned researchers who intend to use this data collection method with some limitations that they may encounter while conducting the study, which is the researcher effect. The presence of the researcher while the event is taking place may somehow influence the participant actions, but it may be reduced over a longer period, yet remain a potential issue. Measures to be taken into consideration when the researcher is collecting data using non-participant observation is to build a sense of mutual trust and develop empathy with participants as much as possible, while simultaneously making sure to avoid over-empathising with participants. Furthermore, the researcher must be in a position of visual aids to be used to aid in gathering data, the researcher must not trust his/her own memory, however, participants must be aware of such data collection aids (Liu & Matlis, 2010).

Thus, after the semi-structured focus group interviews, the researcher asked permission from the School Management Teams (SMTs) to visit one Grade 10 Physical Sciences class per school during the teaching and learning session at which twelve teachers were observed teaching science to establish how they embed formative assessment in their classroom practices, specifically addressing the research objectives 2 and 3 which ascertain how Grade 10 Physical Sciences teachers embed formative assessment in their classroom practice and determine the challenges that Grade 10 Physical Sciences teachers' encounter during embedding formative assessment in their classroom practice. During these sessions the researcher made use of a structured observation schedule consisting of ten critical aspects being observed (see Appendix B) and also recorded other additional observations that had necessary bearing to the lesson taught. The researcher acted as a non-participant observer, observing one lesson in each school from the twelve sampled schools.

Twelve lessons were observed and each lesson lasted for 50 to 60 minutes, depending on the time allocated for periods in each school's timetable, it was noted that all the observed lessons were taking COVID 19 protocols into considerations such as social distancing in the classroom, sanitizing were done regularly and all learners, the teacher and the researcher wore masks throughout the observed lesson. Each observed lesson was systematically recorded based on the observation schedule. Kumar (2019) argues that observations are major means of collecting data especially if the study is qualitative in nature. Thus the information gathered through observations offered a first-hand account of the phenomenon, and when combined with interviews, they presented a holistic interpretation of the phenomena being investigated. This study specifically explored the nature in which science teachers embed formative assessment in their classroom practices and the challenges observed in doing so.

### 3.5.3. Pilot Testing

Pilot testing is a critical aspect in a research study that is used to check the reliability of the research instruments, the feasibility of the study protocol and the acceptability of intervention. A pilot study is important in enhancing the quality and efficiency of the research study. However, pilot testing also helped the researcher to assess the safety of participants and assess the blinding process, thus increasing the researcher's experience with relevant research methods that must be in place. De Vos et al., (2011) assert that pilot testing helps the researcher to modify research questions, thus testing the study feasibility and questions based on comprehensibility, simplicity and unambiguity that might hinder the quality findings, they further allude that once the pilot testing has been done some questions may be modified or reworded based on the input collected through a pilot study.

A pilot test was performed with a semi-structured focus group interview consisting of four teachers from four high schools from eManyiseni circuit which was not part of the sample. The teacher who teaches Physical Sciences in Grade 10 were used in the pilot testing as sample participants, the semi-structured interview schedule was used to interview participants at the pilot schools. The questions were categorised and based on the objectives of the study. Under objective 1, there were three sub-questions, under objective 2, there were two sub-questions, and then under objective 3 and 4 there was only one sub-question. Probing questions were used to allow the participants to elaborate on their answers. In addition, the researcher used follow-up questions or prompts to ensure that he obtained optimal responses from the participants. The pilot exercise was useful, and thereafter the researcher did not make any changes as all the questions were relevant and important in achieving research objectives.

Two Physical Sciences lessons during pilot testing were also observed using the observation schedule template prepared beforehand. The observation sheet consisted of ten aspects observed during assessment practices, addressing research objectives 1, 2, 3 and 4. The pilot exercise was beneficial and effectively prepared the researcher for actual lesson observations. The COVID 19 protocols were adhered to while pilot testing was in place.

## 3.6. TRUSTWORTHINESS

Four indicators are used to determine trustworthiness in qualitative research: credibility, transferability, dependability and confirmability (Kumar, 2019). Credibility refers to truthfulness and accuracy of results, transferability refers to the extent to which results can be transferred to other contexts, dependability refers to the extent to which similar findings would be obtained if a similar study was undertaken at a different location and/or time using participants who have the same characteristics, while confirmability refers to the extent to which the results are free from bias so that findings can be replicated by other researchers (Kumar, 2019). The researcher collected data using both interviews and observations (triangulation) to ensure the credibility of the findings. In addition, the researcher made a thick description of the study and provided an audit trail through data analysis to enhance transferability and confirmability. Furthermore, the researcher requested colleagues to verify the coding and analysis of results to enhance dependability. The indicators are therefore explained in detail below.

### 3.6.1. Credibility

This indicator of trustworthiness is about establishing that the findings of the study are believable; it imposes quality rather than quantity (Noble & Smith, 2015). Thus, that implies that credibility lies more upon the richness of the data that has been collected, unlike the amount of the data that has been collected. Noble and Smith (2015) further state that there are many different techniques that the researcher can use to gauge or weigh the accuracy of the research findings, such as triangulation data. In essence, the participants of the study are the only ones who can effectively judge the credibility of the research findings. Credibility in the qualitative study requires the researcher to examine the experiences, beliefs, perceptions and understanding of the participants, thus the researcher in this study did consider all those aspects from the sampled schools with regard to embedding formative assessment in their classroom practice. The participants were the actual role players in this study in the sense that they were real people to best judge the accurateness of the study findings, thus confirming the credibility of the study.

The researcher also used the strategy of triangulation to enhance the richness and accuracy of the collected data. Creswell (2011) posits that triangulation involves corroborating evidence from other individual types of data collected qualitatively through description and themes. In order to ascertain how Grade 10 Physical Sciences teacher's, embed formative assessment in their classroom practice, their lessons were observed using two data collection instruments, namely, semi-structured focus group interviews and non-participant observations. The researcher also appreciated the competencies of his supervisor with expertise in checking the data analysis against the data collection process for any biases, emotions and feelings that may have been risen. To maintain the credibility of the study, the researcher also provided participants with transcripts and data analysis to ensure the accuracy of the data description and research findings.

### 3.6.2. Transferability

This indicator of trustworthiness refers to the degree to which the research study can be transferred to other various contexts that exist in a social setting. Transferability is established by providing readers with evidence and clarity that the study's findings could be applicable to other contexts, situations, episodes, time and populations thus comparing them to a similar situation that they are most familiar with. However, once the specifics and elements are comparable, then the original research study can be regarded as more credible; to arrive at this point, the original research study must supply a highly detailed description of the phenomena and methods (Noble & Smith, 2015). In a qualitative study, the findings cannot be generalised in line with the large population. Thus, to enhance the transferability of this study the researcher provided detailed descriptions and outlined all the necessary steps and stages undertaken.

### 3.6.3. Dependability

This indicator is about ensuring that the research findings are consistent and could be repeated. However, dependability rest squarely on the measures by the research that is conducted, analysed and presented. Each process in the study should be explained in detail to enable the external researchers to repeat the study and achieve the same or similar findings. This allows researcher to understand the method and its effectiveness. In this study, the researcher made use of reliability auditing in which external examiners actually checked the researcher's activities from a critical perspective to assess the dependability of the procedures used and followed to complete the study.

### 3.6.4. Confirmability

Confirmability in a study usually questions how the research findings are supported by the collected data. This process is essential to check whether the researcher has been biased during the study or not; Kumar (2019) emphasises that the researcher must remain neutral in the analysis of the research procedures. To enhance the confirmability of the study, the external researcher can make judgements by studying the collected data in the original inquiry. However, to confirm the conclusion of the study, an audit trail can be made throughout the study to demonstrate how each decision was made (Lincoln & Guba, 1985; Noble & Smith, 2015).

The researcher of this study remained neutral during the data analysis to avoid own bias from research procedures and research findings. In that manner, the study findings are the outcomes of the perceptions, beliefs, experiences and understanding of the participants from the entire collected data process, and not those of the researcher. Moreover, in the analysis of the data, triangulation and a descriptive approach were employed to limit the researcher bias and assist the reader on how collected data was analysed. The researcher has maintained a consistent investigation process, which was explained step by step ranging from the initial stage through to the findings to allow the readers to effectively monitor and understand the process.

## 3.7. DATA ANALYSIS

Due to the qualitative nature of this study, the analysis of data included verbatim transcripts from semi-structured focus group interviews. The collected data were coded based on the different main themes by analysing the information gathered in the field. It is crucial to take note that interviews were transcribed verbatim into parts, categorised and patterns were established. The data collected through interviews were examined to gain a general description of the context explained by the participants (teachers). After the general description of the data, coding was performed based on the study categorisation. Concepts and words preferred by the participants of the study were included during the coding process to preserve the meaning stressed in the texts. Emerging themes were formulated from participants' narratives. Confirmation in the form of direct quotations from the participants was introduced to ensure the reliability of the qualitative research (Patton, 2014). Pseudonyms were used on verbatim sentences, instead of the real names of the participants to maintain anonymity. All participants correspondingly were coded from T1-T12, where T referred to Teacher and 1 was the number of the sampled school.

When all the data from semi-structured focus group interviews and non-participant observations had been collected, the researcher used thematic analysis to compare and contrast explanations and descriptions of the phenomena under study. The thematic analysis of data collected involves analysing transcripts, identifying significant themes and putting those themes together according to their characteristics (De Vos, Strydom, Fouche & Delport, 2011). The researcher read the data thoroughly several times to come up with correct central themes that were coded and recorded into well-refined categories from which the descriptive phenomena investigated were established.

The researcher considered transcribing the data as the point of departure in the process of data analysis, and thereafter carefully looked at collected data through semi-structured focus group interviews and classroom observations and considered some critical steps in analysing the qualitative data collected (Gay, Geoffrey & Airasian, 2012). Thus after the semi-structured focus group interviews data had been transcribed, then the researcher familiarised himself with collected data by reading through them several times or repeatedly. Thereafter the researcher identified the emerging themes, so the data were classified by categorising and coding pieces of data and physically grouping them into themes and then the organised data were interpreted and synthesised.

## 3.8. ETHICAL AND SAFETY CONSIDERATIONS

McMillan and Schumacher (2010) point out the importance of ethical considerations, stressing that the qualitative researcher must be sensitive, informed and consider carefully the ethical principles according to the nature of the research topic. This study was conducted in public schools and thus all the necessary ethical considerations were adhered to. The following considerations and permission were sought:

- A letter requesting permission to conduct research was forwarded to the KwaZulu-Natal provincial Head of the Department of Basic Education seeking permission to conduct research in selected schools.

- A letter was also forwarded to the director of UMkhanyakude district requesting permission to conduct research in high schools within the FET band in the district (see Appendix C).
- A letter was forwarded to the principals of the target schools seeking permission to conduct the research (see Appendix D).
- Permission was sought from the University of Zululand for Ethics Committee, which issued a clearance certificate (see Appendix G).

Safety and Ethical consideration for this study included informed consent, confidentiality, anonymity, voluntarism, privacy and freedom, non-harm, care and fairness and thorough and truthful reporting of the research findings. However, collecting data without thoroughly informing participants and without considering fully the expression of willingness and informed consent is regarded as unethical (Kumar, 2019). Thus the researcher provided all the participants with informed consent forms ensuring they were made fully aware of the type of information that the researcher sought from them, why the data was being collected from them and what were the reasons for collecting the data.

Participants also had the right to know in advance how they are expected to participate in the study and how it would affect them, thus all participants were informed accordingly prior to the data collection process. In this study, the participants were told that the information provided will be treated with confidentially and anonymity was maintained throughout through the use of pseudonyms. In addition, the researcher treated all participants with care, respect and courtesy.

Kumar (2019) emphasises the importance of signing an informed consent form just before participants embark on the study, hence this process was correctly addressed. The participants were given consent forms and it was thoroughly discussed with them during both the semi-structured focus groups interviews and classroom observation (see Appendix E & Appendix F). Clarification was provided, where possible and questions were answered. After participants had signed the consent forms, the copies were filed for future references. The signing of consent forms was the recognition means that showed that participants were willing to take part in the research study. In addition, the consent form did acknowledge that the interests and dignity of participants would be secured and respected during the course of data collection.

Participants were given feedback based on the findings after the completion of the study and the researcher acknowledged their participation and the role they had played. Feedback was provided through a briefing session where the researcher presented the results at the end of the study to determine whether the research findings were a true reflection of the views of the participants. This also assisted the participants to have an assurance that their dignity was secured as it would not mention their names, instead, participants were addressed with pseudonyms, using the word ‘teacher’, especially during the interviews and observations.

Lastly, the researcher mentioned clearly to the participants that their participation was purely voluntary, meaning that all those who take part in this study are doing so willingly and no compensation shall be provided. It was important as well to provide the participants with a withdrawal option should they wish to do so. The participants in this study were adequately informed of the valuable and meaningful contribution they would make as they participated in the study regarding embedding formative assessment in their classroom practices at Grade 10 when they are teaching Physical Sciences.

## 3.9. LIMITATIONS

The researcher was aware that this study was limited to the UMkhanyakude District in the Northern part of the province of KwaZulu-Natal, which is one of the nine provinces in the Republic of South Africa. Only one circuit, the Inkosi Sambane Circuit, was targeted for the study, and the sample was limited to twelve high schools in this circuit. However, one teacher per school was sampled; a total of twelve (12) teachers who taught Physical Sciences in the FET phase at Grade 10 were selected for three focus group interview sessions and non-participant observations. While the researcher intended to include schools from urban areas, this could not happen since Inkosi Sambane Circuit is a rural-based circuit at UMkhanyakude District. In some schools, classroom observations were conducted while teachers feared being observed by an outsider (the researcher) as they were teaching. However, the researcher was still able to observe all twelve lessons.

### 3.10. CHAPTER SUMMARY

This chapter highlighted certain aspects that formed part of the methodology used in this research study. A qualitative approach and interpretivist paradigm were adopted and employed in this study, hence there were also explained in detail. The researcher used a multiple case study to find an in-depth understanding of how teachers embed formative assessment in their practice. The advantages of adopting a multi-case study were also highlighted. The specifics on the targeted population, sampling procedure and sample size were explained in detail, and the reason why the purposive sampling method was adopted, to come up with a small sample size of participants was discussed in detail.

The data collection instruments, that is, semi-structured focus group interviews and non-participant observation were also discussed broadly with their advantages and implications. Besides eliciting research data using focus group interviews and observations, the researcher found it important to undergo the pilot testing process to validate the data collection instruments prior to the actual data collection process, thus it was indeed explained in this chapter. Trustworthiness indicators such as credibility, confirmability, dependability and transferability were highlighted to enhance the quality of the study. Finally, the ethical and safety consideration issues and procedures followed up to the actual data collection, analysis and interpretation were highlighted as well.

# CHAPTER FOUR

# DATA ANALYSIS AND INTERPRETATION

## 4.1 INTRODUCTION

In the previous chapter, the research methodology used for this study was presented and discussed; this included the research paradigm and design, ethical and safety considerations, trustworthiness of the instruments as well as procedures for data collection to answer the research questions for the study. This chapter presents a systematic analysis and interpretation of collected data from the semi-structured focus group interviews with teachers and non-participant classroom observation with teachers currently involved in teaching Grade 10 Physical Sciences at Inkosi Sambane circuit schools. Data analysis and findings of this study are presented in two parts which are semi-structured focus group interviews and non-participant classroom observations based on the qualitative approach to address the following research objectives of the study:

- Explore Grade 10 Physical Science teachers' perspective of embedding formative assessment in their classroom practices.
- Ascertain how Grade 10 Physical Science teachers embed formative assessment in their classroom practices.
- Determine the challenges that Grade 10 Physical Science teachers' encounter during embedding formative assessment in their classroom practices.
- To identify the classroom support and guidance that is available to Grade 10 Physical Science teachers in embedding formative assessment in their classroom practices.

Table 4.1 below reflects the themes that were generated from the research questions.

**Table 4.1: Themes aligned to research questions**

| RESEARCH QUESTIONS | THEMES |
|---|---|
| 1. What are the Grade 10 Physical Sciences teachers' perspective of embedding formative assessment in their classroom practice? | • The conceptualisation of using formative assessment in a science classroom<br>• Planning of formative assessment for science lessons<br>• Integration of formative assessment in enhancing learners understanding in a science classroom. |
| 2. How do Grade 10 Physical Sciences teachers embed formative assessment in their classroom practice? | • The nature of how teachers embed formative assessment in their classroom practice<br>• The essence of providing feedback to the learners in a science classroom |
| 3. What are the challenges that Grade 10 Physical Sciences teachers' encounter during embedding formative assessment in their classroom practice? | • Challenges encountered in embedding formative assessment in classroom practice |
| 4. What are the classroom support and guidance available to Grade 10 Physical Science teachers in embedding formative assessment in their classroom practice? | • Classroom support and guidance to implement formative assessment in a science classroom |

Findings have been presented with the use of pseudonyms: T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11 and T12. T1 represents a teacher from the first sampled school while T2 represents a teacher from the second sampled school and so forth until T12. In sorting the responses, statements that projected similar ideas and views were grouped together into the themes highlighted in Table 4.1 above.

## 4.2 THEMES

### 4.2.1 Theme 1: The conceptualisation of using formative assessment in a science classroom

The conceptualisation of formative assessment refers specifically to the participants' understanding of the concept. Since formative assessment is critical and plays a fundamental role during the teaching and learning process, it is necessary for teachers to have a clear understanding of the concept so that they may appropriately embed formative assessment in their practices to ultimately enhance learning. During the semi-structured focus group interviews, participants were asked about their understanding of formative assessment and using it in their science classroom practices. Findings from the responses gathered during the interviews with the participants revealed that the majority of the participants did not explicitly understand the concept of formative assessment as a result they struggled to effectively integrate formative assessment in their classroom practice such that they can achieve and meet their learners' needs.

The following responses about the conceptualisation of formative assessment in a science classroom were articulated by participants, clearly indicating a lack of understanding of the concept 'formative assessment'; Participant T12 asserted:

> *''I think formative assessment is the formal assessment; it just a data-based tests'' (T12)*

The response from participant T4 indicates that much emphasis is placed on the completion of previous question papers rather than focusing more on assessment for learning and how it may be integrated into their science classroom:

> *"Formative assessment is about allowing learners to present their ideas in front of the class about the topic of the day and using previous question papers so that they won't struggle when the final examinations come" (T4)*

As a result of not clearly understanding the concept of formative assessment, teachers were not able to effectively explain how they integrate it into their practice; this was also evident during the classroom observations. Further adding to participant T4, participant T7 also emphasised the practice of using examination guidelines and previous question papers while not fully conceptualising that they are merely teaching for summative purposes only and not for understanding. It is critical that teachers have a clear understanding of the connection between summative and formative assessment so that they may effectively use the information gathered to capacitate learners accordingly, instead of teaching for summative purposes only and not for understanding.

> *"When I am using formative assessment in the science classroom, I usually refer to the examination guideline and previous questions papers from various provinces so that when they are writing the test they don't face difficulties" (T7)*

Participant T6, on the other hand, adopts the questioning strategy to guide and support learners; however, the nature and manner in which these questions are integrated make a difference:

> *"When I'm using formative assessment in a science classroom I only write questions on the board at the end of the lesson and learners solve it on their own, and it where I can able to identify learners that have problems" (T6)*

Formative assessment in classroom practice is an ongoing process that is said to improve learners' achievement of the desired instructional outcomes to close the gap that exists in learners' understanding. From the above findings, it stands to a reason that participants did not clearly understand the concept of formative assessment and thus struggled to effectively integrate it into teaching and learning in the science classroom. Therefore, learners' understanding will not be enhanced if the formative assessment is not effectively implemented by the teacher.

This is supported by Young and Kim (2010) who conceptualise formative assessment as the 'heart' of assessment that is flexible where teaching and learning activities can be modified and adapted; the teacher must be the role player with a vast understanding about the implementation of formative assessment. Similarly, Wiliam (2011) is of the view that for teachers to use formative assessment effectively, they must possess a deep understanding of the concept, an understanding of how learners learn as well as a modification of learning.

### 4.2.2 Theme 2: Planning of formative assessment for science lessons

This theme relates to the planning of formative assessment by science teachers before the actual implementation of the science lesson. For Physical Science teachers to be responsive, they need to plan for formative assessment opportunities, as a result this will help them to know the questions that will prompt or stimulate thinking and discussion. Planning also allows the teacher to recognise and identify difficulties or misconceptions learners might have with the topic area. Findings gathered through semi-structured focus group interviews indicated that the majority of the participants plan for integration of formative assessment, so they use various resources in the preparation phase to enhance learners' understanding and accommodate learners with diversities to achieve lesson objectives during the science lessons.

The following responses about the planning of formative assessment for science lessons were conveyed by participants during classroom observations. Participant T1 stated that he does planning and proper planning is the only way to prevent hindrances that might occur while embedding formative assessment in the science classroom, therefore, it should be every teacher's responsibility to plan for formative assessment in science lessons:

> *"I do plan for formative assessment and the fundamental thing here is to understand that teaching and learning in a form of formative assessment is the process and it must occur unhindered in science lessons, so to prevent such hindrances it is every teachers' responsibility to plan by writing lesson plan where he or she articulates the formative activities to be done while science lesson is in place" (T1)*

One of the participants remarked that even though writing a lesson plan is a basic requirement for every teacher before going to class as it is stipulated in the CAPS document, when she is planning a science lesson, she even goes beyond the prescribed planning documents and searches for more information on the internet to have a productive and effective lesson. Participant T5 asserted:

> *"Before going to the classroom I prepare the lesson not only by writing the lesson plan, I even take different textbooks to find more information and I go to the internet to search the information that shall assist my learners in the understanding of any scientific concept presented to them" (T5)*

Interestingly, one of the participants commended the Department of Basic Education for providing teachers with important documents that are regarded as key pillars of planning for all activities that might take place in a classroom setting. These documents have stipulated time frames for each aspect and recommended activities the teacher can adopt while embedding formative assessment. Participant T6 asserted:

> *"When I'm planning for formative assessment in science lessons, I usually use CAPS document and ATP in conjunction with textbook because in CAPS document all formative activities the teacher can adopt are clearly articulated and in the ATP time frame per aspect is indicated." (T6)*

Sharing the same opinion was another participant who declared that planning is necessary for every science teacher because when the planning is thoroughly done the diversities of learners in the science classroom are catered for and accommodated in the planning, hence no learner shall be left behind. Participant T12 stated:

> *"Planning for formative assessment in science is the vital step and it is every science teacher's responsibility to plan thoroughly, where you outline as a teacher on how are you going to accommodate the diversity of learners so as to enhance their scientific understanding" (T12)*

It should be considered that in order to help learners to have clarity in terms of 'where they are going', learning objectives work best if they are clearly articulated and decontextualised in the planning phase. This implies that planning is the backbone behind learners' understanding. However, it can be noted that when a science teacher is planning for formative assessment, various sources of information must be considered and used efficiently towards achieving learning goals. Hattie and Timperley (2007) claim that planning for formative assessment and supporting learning can be considered in terms of a continual process of gathering and responding to evidence; this involves identifying learning goals in planning, assessing progress towards those learning goals, and adapting the teaching to enable learners to make better progress in their learning.

### 4.2.3 Theme 3: Integration of formative assessment in enhancing learners' understanding in a science classroom

Formative assessment demands appropriate and effective integration in a science teacher's classroom practice in order to enhance learners' understanding and to enable them to successfully grasp scientific concepts. Findings gathered during the semi-structured focus group interviews revealed that teachers integrate this assessment using different methods and strategies such as small group discussions, written and oral feedback, peer assessment, questioning, as well as flow diagrams and concept maps. The researcher also noticed during the classroom observations that integrating different strategies helps the science teachers to gain insight into the varying levels of comprehension within the classroom thus providing learners with opportunities for application and evaluation of skills learnt.

The following responses were recorded during the interviews which indicated how teachers integrate formative assessment in science classroom practices. Participant T12 explained that the element he considers when integrating formative assessment is the frequent use of small group discussions where learners complete group activities and also adopt peer assessment as these help learners to grasp information easily while learning, supporting and assisting each other during the process.

> *"One of the elements that work better for me when integrating formative assessment is the group activities and also peer assessment as this helps my learners to understand better if one of their peers in the group is explaining certain scientific concepts, it also promotes respect, mutual understanding and togetherness among learners, these learners seem to gain a lot from working with each other" (T12)*

Although some participants mentioned overcrowding as a challenge when integrating formative assessment in a science classroom, participant T5 indicated that the school where she is working is a rural area and classes are overcrowded but when integrating formative assessment, she ensures that in all activities, both oral and written, she provides feedback to her learners. Participant T5 asserted:

> *"The school where I am employed is at deep rural area of UMkhanyakude with overcrowded classes, but the element that I normally use when integrating formative assessment is a feedback mechanism in a written and oral way, and I believe that providing feedback to learners help them to correct their mistakes and have a better understanding'' (T5)*

Participant T9 remarked that the integration of formative assessment in a science classroom using concept maps and flow diagrams assists learners with diverse and special needs because it shows the various steps on how particular concepts relate to each other visually. Participant T9 said:

> *"When integrating formative assessment in my class I rely mostly on concept maps and I also use flow diagrams as it assists those learners in my class with diversities to fully understand*

*the topic presented to them, I also consider the different levels in Blooms Taxonomy when it comes to assessing them'' (T9)*

However, participant T6 advised that teaching Physical Science must not be taken as an abstract subject that is full of assumptions, instead, the teacher should use educational media for demonstration purposes such as various learner teacher support material (LTSM); this enhances learners' understanding of their classroom practice. Participant T6 who prefers using concept cartoons responded accordingly:

*"When integrating formative assessment, I group my learners and explain to them in groups using different concept cartoons related to the topic and I even use my laptop to project videos explaining how certain reactions and processes occur with demonstrations and that help my learners to understand science better" (T6)*

Findings revealed that when science teachers are integrating formative assessment in a science classroom, it should not be for grading purpose, instead, it should be thought of as work in progress towards ensuring learners' understanding. This implies that to integrate formative assessment into daily classroom practices, different techniques can be considered and used virtually in every classroom setting. This includes communicating feedback, focusing on learners' growth by allowing group and peer-assessment and demonstrations using pictures or visual aids to enhance learners' understanding.

This is supported by Gardiner (2019) where he stated that when teachers integrate formative assessment in the classroom practice, the selected elements should help to provide opportunities for learners' growth, a space where they are free to share their ideas and support their reasoning, thereby enhancing substantive engagement.

### 4.2.4 Theme 4: The nature of how teachers embed formative assessment in their classroom practice

One of the objectives of this study was to better understand how Grade 10 Physical Sciences teachers embed formative assessment in their classroom practices to support and promote learners' learning and achievements towards certain goals. To do so, teachers must use formative assessment strategies consistently and systematically to inform learners about their progress. During the semi-structured focus group interviews, all participants indicated the methods and different strategies they use when they embed formative assessment in their classroom practices. Therefore, the purpose of the classroom observation was to practically observe the manner in which teachers embed formative assessment in their actual practice, corroborating data obtained from them during the semi-structured focus group interviews. This involved ascertaining if teachers do as they say, and whether their classroom practice was aligned with what they had mentioned during the interviews.

Findings gathered during non-participant classroom observations, specifically on how teachers embed formative assessment, revealed that teachers design formative assessment by planning and preparing structured lesson plans. Prior to the observation of each lesson, the researcher reviewed participants' lesson plans. However, in the majority of lesson plans reviewed, it was noted that the sections about expanded opportunities for meeting learners' needs and their diversity was not included. This makes it difficult for the struggling learners to grasp a deeper understanding of the lesson presented to them as their needs were not adequately accommodated in the teacher's lesson preparation. This is supported by Wasserman (2012) where he alluded that to meet learners' needs, firstly, the teacher must understand the difficulties learners encounter and, thereafter, the teacher must address those needs in the lesson preparation.

Notably, in the majority of the lessons observed, the researcher found that the teachers mainly made use of the questioning technique as highlighted during their focus group interviews. I observed that their main purpose of using questioning as a formative assessment strategy was to determine what their learners already know in that specific science lesson in an attempt to steer the lesson towards exactly what learners need to know. However, the majority of these questions were lower cognitive, as their focus was simply on just recalling and remembering, meanwhile only few of the questions were also pitched in a manner that allowed critical thinking in learners.

According to Florez and Sammons (2013), if questions are insufficiently challenging, learners' critical thinking is being suppressed, therefore, the teacher must ask questions that stimulate critical thinking. This provides learners with enough waiting-time to think about the question posed to them. It also implies that when a science teacher adopts questioning as a strategy during the formative assessment, they would need to ask questions that promote discussion and substantive engagement amongst learners. The researcher also observed that not much time was allocated for learners to stop and think, so that they may come up with constructive answers. Grant (2014) emphasises that when employing the questioning strategy, especially during the formative assessment, it is critical that the teachers consider increasing the waiting time for learners, to provide them with more time to think so that they may eventually come up with meaningful answers.

Research evidence (Busch, 2016) indicates that feedback is one of the key elements the teacher can use when embedding formative assessment in their classroom practices, as it can be an effective way of learning if used appropriately. During the semi-structured focus group interviews, participants indicated that they usually provide feedback to learners after certain activities have been administered. Similarly, the researcher further observed that teachers do provide feedback using different methods such as oral, written and individual feedback.

It was observed that participant T1 mainly focused on providing learners with feedback in the form of corrections written on the chalkboard and not individually because of the large number of learners in the classroom. On the other hand, during observations participants T2, T6, T7 and T11 used individual feedback mechanisms to correct their learners as they were just moving around the tables to check on how learners answered questions.

Thereafter, the teacher politely provided each learner with clarity on how to tackle a question if there was a misunderstanding. I observed that they were able to effectively adopt that strategy because of the small number of learners in their classroom. Hattie and Timperley (2007) are of the view that the teacher, as the feedback provider, must carefully analyse learners' tasks before providing the feedback because the nature of the task determines how feedback must be provided.

Participant T9 in the semi-structured interviews indicated that the element she considered when embedding formative assessment is the peer assessment with an understanding that learners learn better if they discuss every aspect with their peers. During classroom observation, participant T9 made use of peer assessment in small groups where learners were asked to discuss concepts and come up with their collective understanding while the teacher was acting as a facilitator of learning. Participant T9 moved the learning from being teacher-centred to being learner-centred, encouraging active participation and discussion in their small groups. I observed that if learners are working closely and interacting with their peers, their responses were meaningful and showed better understanding.

This is supported by Spiller (2012) whose study found that peer assessment naturally moves learning from a teacher-centred to a learner-centred encounter and that increases the level of confidence and engagement among learners. Learner participation is also enhanced due to the mode of learning. The findings of the aforementioned study revealed that science teachers attempt to embed formative assessment in their classroom practices using different strategies that are suitable and in favour of their classroom environment.

### 4.2.5 Theme 5: The essence of providing feedback to the learners in a science classroom

This theme attempts to establish the essence of how science teachers provide feedback in their science classroom. Feedback is a vital part of any learners' skillset and plays an important part in the learning cycle. It is not just about giving feedback, but also receiving it is essential, suggesting to learners what to consider next, thus providing a variety of opportunities to enhance the learners' future learning. During the semi-structured focus group interviews, participants indicated how they provide feedback to their learners. These included writing corrections on the chalkboard, giving individual feedback after certain activities have been administered and providing verbal feedback to small groups of learners during the activity in the classroom.

Findings gathered during classroom observations revealed that constructive feedback is a robust tool for creating a healthy environment, boosting productivity and engaging learners, and achieving better results. The researcher further observed that feedback positively influenced communication, learners' interaction, and small group work activities, thus motivating and stimulating learners to do better. During the interviews, participant T6 indicated that he writes corrections on the chalkboard when providing feedback as that method is learner-friendly because as he writes the corrections he also elaborates verbally using practical examples and highlighting common mistakes during the activity. This was also evident during the classroom observation. The researcher further observed that when elaboration is used effectively with a positive tone, it assists learners to accept the feedback and apply it to their future work, rather than just writing corrections without elaboration and explicitly expanding on how adjustments may be made moving forward, thus feedforward.

Feedback should be personalised and directed towards one learner or a small group of learners. The researcher observed that participant T8 preferred providing feedback in small groups; the teacher was moving around attending and giving learners the feedback in those small groups. Furthermore, the researcher deduced that if the feedback is directed to the whole class, learners tend not to use feedback effectively. This is supported by Carless (2006) who found that if the feedback is delivered and directed to the whole class, learners often do not listen to or make use of feedback because they somehow think it does not specifically apply to them.

I also observed that overcrowded classrooms were of serious concern and it directly affected the nature and timing of feedback.  Although the situation of overcrowded classrooms was a difficult issue to address, the researcher observed that Participant T1, when providing the feedback, was having a large number of learners in the classroom; while the teacher provided feedback she prioritised only important aspects in giving feedback. Similarly, Hattie and Temperley (2007) contend that feedback should be concise and focus on areas of strengths and growth that will have the greatest impact on the learners' learning. Concise and prioritised feedback is more digestible for learners and easier to be internalized and implemented.

In particular, Participant T9 preferred providing feedback to individual learners to cater for learners' needs and diversities effectively; however, that is subject to the number of learners the teacher has to engage with. During classroom observation, Participant T9 was having a small number of learners thus he was able to provide the feedback to learners individually. The researcher observed that individual feedback was ongoing, consistent and timely; this means that learners, especially those with diversity, were provided with ample opportunities to internalise and use feedback. Busch (2016) is of the view that when the feedback is not timely, learners are disengaged and demotivated. Therefore, every teacher must provide feedback regularly to address the loops learners encounter.

The above findings revealed that feedback is something that every learner can benefit from, whether it is offered digitally, verbally or through the traditional written annotations on activities or corrections on the chalkboard. This variety of feedback opportunities makes it easy to incorporate learner participation and engagements. Giving oneself time to provide valuable feedback to learners' questions on the underlying assumptions enhances learning. Although teachers face challenges with large class sizes, they attempt to seek different ways in which feedback may best work for them and their learners, although individual feedback for personal improvement is sacrificed.

#### 4.2.6 Theme 6: Challenges encountered in embedding formative assessment in classroom practice

Apart from schools having challenges as they endeavour to achieve their set goals, teachers themselves experience and encounter challenges as they embed formative assessment in their science classroom. In this section, the researcher systematically discusses and analyses the challenges revealed by science teachers during the semi-structured focus group interviews and those that was observed by the researcher during the classroom observations.

The theme on the challenges faced by science teachers was evident; it shed light on challenges that hinder the effectiveness and efficiency of embedding formative assessment in Grade 10 Physical sciences classroom. The rationale behind this theme was that proper implementation of formative assessment in a science classroom could produce learners with scientific skills and expertise in response to the labour market. The following challenges emerged from the semi-structured focus group interviews and were also observed during classroom observations.

##### 4.2.6.1 Overcrowded Classrooms

Findings gathered from participants during semi-structured focus group interviews revealed that overcrowded classrooms hinder science teachers from effectively integrating formative assessment as they struggle to provide personal attention to each learner, and also tend to limit science investigation formative activities as it place an extra burden on them. Confirming the negative impact on learners because of the overcrowded classroom was participant T12, who asserted that before COVID 19, the number of learners in classrooms were ranging from 45 upwards:

> *'Our classrooms are overcrowded, that is the serious challenge because learners do not pay attention to their work, even us as teachers we fail to control all learners due to overcrowded classrooms almost 45 learners or more, also controlling individual learner is time consuming and so tiring on us' (T12)*

The above statement was corroborated while the researcher was observing the lesson in sampled school number 12. The researcher observed that apart from the classroom space being overcrowded, which was a challenge for the teacher to move around to all learners, the classroom arrangement inhibited interaction among learners during small group discussions. This further limited the quality and quantity of formative activities. It was observed that overcrowded classes led to discipline problems. A lack of science resources such as apparatus to be used by learners limited the integration of resources to enhance learning. It can be noted that the class size automatically adds to science teachers' workload as they have to prepare lessons effectively, mark activities in order to provide constructive feedback. Such a load negatively impacts on the teachers' integration of effective formative assessment in their classroom practices.

#### 4.2.6.2 Lack of Resources (Physical and material resources)

The lack of resources that commonly emerged as having an impact on embedding formative assessment in a science classroom by participants during the semi-structured focus groups were science laboratories, experiments apparatus and chemicals to perform reactions as stipulated in Physical Sciences Grade 10-12 CAPS document (Department of Basic Education,2011). Among the participants who indicated the lack of resources as a challenge on embedding formative assessment was Participant T8 who confirmed that:

> *'The challenge that I face every year when integrating formative assessment in a science classroom is the shortage of physical resources, for example when I want to perform certain practical and experiments with learners we face the challenge of not having the science laboratories' (T8)*

The above remarks from Participant T8 depict the disparity that exists between practical and theory when it comes to embedding formative assessment in the science classroom. However, that implies that the social constructivism theory is not integrated into the lesson as it requires learners to use tools in a social setting to make meaning of what they have learnt. The researcher further observed that the absence of physical resources in a science classroom setting is a challenge in the integration of formative assessment as learners are only exposed to theory. Thus scientific understanding through observation and hands-on activities are neglected which limits learners' active involvement.

Although participants reported a lack of physical resources as a challenge, participant T10 indicated the material resources as the challenge as well. However, participant T10 advised that science teachers must improvise in responding to the lack of material resources to enhance learners' understanding. He stated:

> *'Experiments are more important in science learning, even if you are in a rural area with insufficient material resources to do experiments, teachers must improvise by using materials from their homes such as glycerine and potassium per magnates called umanyazini in order to perform reactions so that learners can practical understand reactions other than teaching reactions with theory' (T10).*

According to Lyon (2012), learning is a complex activity that involves an interplay of learners' motivation, physical resources, teaching resources, and skills of teaching demanded by the curriculum. Therefore, it implies that when science teachers embed formative assessment, the necessary resources should be readily available in support of integration of formative assessment; resources such as laboratories, chemicals even teachers and support staff are critical.

#### 4.2.6.3 Availability, Accessibility and Suitability of learner teacher support materials (LTSM)

For the integration of formative assessment to take place effectively in a science classroom, a variety of learner teacher support materials (LTSM) are necessary to make the teaching and learning of science more effective and productive. These may include science textbooks, workbooks, e-learning materials, library resources, visual and audible aids, scientific calculators and others.

During semi-structured focus group interviews, Participant T9 indicated that when embedding formative assessment, the challenge she faces is that most of the learners do not have scientific calculators which are regarded as a primary tool that each learner must have all the time when learning science for basic mathematical calculations. This contributes to a high failure rate in science learning as learners are failing to operate calculators when a summative assessment is administered. Emphasising the negative impact of learners not having scientific calculators, Participant T9 asserted:

> *'Availability of scientific calculators in my learners is a serious problem I encounter when teaching science, it takes some time for my learners to get scientific calculators and I find that difficult because most aspects in science we use calculators, therefore if my learners are not in a position of calculators they usually make minor mistakes when calculating in examination' (T9)*

As revealed in semi-structured focus group interviews, Participant T3 commended the Department of Basic Education for having a textbook allocation for every school, especially those that do not belong to Section (21). The participant further stated that the department does provide them with the textbooks; however, the challenge is that those textbooks are not accessible to all learners as they share a single textbook in a group of 3 or more. Participant T3 remarked that:

> *'Learner-support materials such as science textbooks are not sufficient, learners share textbook in groups, as a teacher I am compelled to do copies whenever I am about to give them some formative assessment activities in a classroom and that becomes a challenge to me especial when the photocopying machines are having problems, they also sometimes don't work.' (T3)*

Sharing a similar challenge about insufficient textbooks was participant T5 who stated that the few textbooks provided by the Department of Basic Education are neither suitable nor chosen by teachers; they do not have effective formative activities but rather overemphasise factual information. Participant T5 said:

> *'Teaching science requires the usage of different textbooks that are of the teacher's preference, for example, if I have ordered the Platinum textbooks, the Department will bring Spot On textbook to me and that disturbs my plan and nature of activities in textbooks are not the same' (T5)*

The researcher further observed during the classroom observation that learners share textbooks which tends to hinder the implementation of formative assessment activities.

Besides, some learners who were also allocated textbooks, left them at home, thus exacerbating the shortage. Furthermore, the researcher observed that most of the learners in the classroom did not have scientific calculators and that made it difficult for teachers to teach problem solving specifically using calculations in Physical Science effectively. As findings reveal that learner-support materials are a challenge during embedding formative assessment in a science classroom, the researcher strongly feels that there is a need for the Department of Basic Education to increase the Science education allocation budget to allow schools to purchase a variety of learner-support materials that will be available and accessible to all learners all the time; these must be suitable for science learning - in addition to textbooks provided by the department.

#### 4.2.6.4 Language of Learning and Teaching (LoLT)

The issue of the language of learning and teaching (LoLT) has been a matter of debate for a long time in the South African education sector. The language of teaching and learning is the language that is used as a medium of instruction in schools accepted by the Department of Basic Education in South Africa, which is English. During the semi-structured focus group interviews, the majority of participants indicated that they teach science in English but sometimes they try to elaborate certain concepts in the home language of IsiZulu. This is a challenge because formative and summative assessments are administered in English. Howie (2003) believes that the most significant factor in learning science is not whether the learners are poor or rich, but whether learners are fluent in English or not.

Participant T7 was one of those participants who sometimes use isiZulu home language when explaining certain aspects in depth, and she said:

> *"When I am teaching my learners science I normally use English as a medium of instruction, however, I sometimes explain other concepts in IsiZulu because they understand better since it is their mother tongue but it becomes a challenge because all papers are being set in English, that's when I find that most learners tend to struggle" (T7)*

When it comes to science learning, some learners have challenges with abstract concepts and scientific language. Participant T4 claimed that when learners with special needs are taught using only English as a medium of instruction, these learners have to grapple with much ambiguity, unfamiliarity and uncertainty. This hampers their participation during formative assessment activities as the meaning of the question may be lost to them. Participant T4 stated:

> *'Although code-switching in science teaching is not acceptable, the reason behind using Home language at other time is that I want to clear the confusion that my learners might have for the purpose of making them understand the question clearly so then they will be able to do the formative activities' (T4)*

During the classroom observation, the majority of teachers were code-switching while conducting formative assessment activities. Participant T1, T6, T8, T10, T11 and T12 used code-switching once each to explain the concepts, whereas Participant T2 dominated the lesson with IsiZulu. Participant T9 also used IsiZulu during the lesson several times as a matter of habit or even comfort; that had nothing to do with further explaining or encouraging learners' understanding of scientific concepts. According to Buck (2000), it requires an adjustment to one's science teaching and assessment practices when teaching science to English-as–second-language learners. She specifically stresses the use of a variety of authentic assessment strategies that can accurately assess the development of scientific knowledge of the learners which may include portfolios, pictures and posters, oral responses, long term projects and self-assessments. These may assist struggling learners to succeed.

#### 4.2.6.5 Reputation of Physical Sciences as a 'Hard Subject'

The debate about learners' perceived disparity in the difficulty of Physical Sciences has occurred over many years and that might be the contributing factor to the low production of scientists in our country. During semi-structured focus group interviews, participants indicated that learners regard science as a hard subject, which hinders their participation during formative assessment activities.

Participant T9 believes that science is not a difficult subject, but science learners should spend more of their time studying and parents must support learners by proving them with necessary basic resources such as calculators.

> *'Some of the learners have that mentality of thinking that science is the difficult subject, in general science is not difficult and I don't know how to change their mind but it requires learners*

*to spend more of their time studying and parents should try to assist learners like buying them calculators and other stuff' (T9)*

Science learners must allocate time for additional activities such as review of the work done in a classroom, doing additional exercises and doing homework. Participant T11 confirmed that by saying:

*'Physical Science is not a difficult subject as learners thought, the only thing science learners need to do to better understand Physical Sciences is to do proper studying and complete all the different activities all the time' (T11)*

Participants think that learners would simply have to do more work so that they perform better in science; this somehow will not directly influence their mind-set. However, they fail to realise that as teachers they would need to assist learners to overcome their difficulties and influence their perceptions by making science appealing and personally relevant through their teaching and by integrating innovative formative assessment practices.

#### 4.2.6.6 Parental Involvement and support

Parental involvement refers to a situation where parents are directly and actively involved in the education of their learners. The strong collaboration of parents with the school can lead to an increased improvement in learners' academic performance. The majority of the participants indicated that when teaching science, the element of parental involvement and support is lacking and that becomes a challenge to teachers as they are not able to discuss the progress of learners with parents.

The view on the importance of parental involvement and support was emphasised by participant T9:

*'Most of our learners are coming from illiterate background, parents are not aware on how the school operates in that case they tend not to involved in the education of their learner, they should be helping and supporting their children' (T9)*

Sharing the same opinion was another participant who declared that parental support is the key behind learners' success; parents also financially struggle to pay for field trips and excursions which would enhance the learning of science. Participant T2 explained:

*'In other time we usually visit different centres and companies with science learners with aim of making understand how chemicals and science-related things are being produced, but most of the parents do not pay for their learners and that becomes a challenge to me as an educator' (T2)*

From the above findings, it can be deduced that one of the challenges that hamper effective parental involvement and support is low income, and this may further add a burden on science teachers because they are expected to produce good results yet they do not receive any support from parents. Another reason for parents not to be involved in the education of their children is the fact that schools sometimes fail to create a strong bond with their parents. This situation is further exacerbated as some parents are unable to read and write and they can only communicate in their mother tongue, which is mainly IsiZulu, thus this makes it difficult for the parents to assist their children with homework; they also fail to encourage the daily use of science concepts and science learning at home.

#### 4.2.7 Theme 7: Classroom support and guidance to implement formative assessment in a science classroom

This theme attempts to establish the kinds of support and guidance available for Grade 10 Physical Sciences teachers when integrating formative assessment in their classroom practices. Findings from both semi-structured focus group interviews and classroom observations revealed that participants from the sampled schools do not receive adequate support and guidance while implementing formative assessment in science classroom practice.

Concerning to the question of the classroom support and guidance that are available to assist science teachers to implement formative assessment in their classroom practices (internally and externally), the responses below were recorded from the participants. They clearly indicate different support and guidance they receive from external officials and internal colleagues, while other participants indicated that they receive little or no support.

Participant T4 explained that in most cases the kind of support that she receives is internal support from the School Management Team mainly about maintaining learner discipline and not specifically concerning enhancing her understanding and practically implementing formative assessment in science education.

> *'In the beginning of each academic year the SMT in my school formulate rules and regulations that will bind learners to co-operate and if the learners is diverging from what he or she signed, the SMT support us by disciplining that learner accordingly following necessary measures, but they do not give us support or any guidance on how to improve our formative assessment practices' (T4)*

Participant T2 commended the support she receives relating specifically to LTSM, which assists in the implementation of formative assessment in the science classroom:

> *'Our science HoD is the one that plays a more prominent role in supporting the implementation of formative assessment by making sure that even if we are in rural areas at least we get LTSM from the Department of Basic Education allocation' (T2)*

Similarly, participant T10 indicated that the support and guidance that is available for him comes in the form of classroom visits and monitoring by the HOD, which culminate in constructive feedback on how to improve his teaching and assessment in science. He stated:

> *'Our science HOD usually visit our classrooms when teaching and learning is in place, although it might render awkward feelings at the beginning but surely after observation, he gave us constructive feedback on how to teach and assess learners, that is the kind of support and guidance that is available in my school internally' (T10)*

It was noted during semi-structured focus group interviews that the majority of participants regarded professional teacher development initiatives like workshops and cluster meetings as the external guidance and support they receive from the Department of Basic Education. Participant 3 was among those who normally attend workshops and cluster meetings organised by the Department of Basic Education, and he asserted:

> *'The guidance and support that is available for us teachers are the cluster meeting and workshops organised by the DBE, however those workshop and cluster meetings are useful and productive to us because they usually organise subject advisors and expert in the field to assist us on how to assess learners and teach them effectively, but these are too few and not enough.' (T3)*

Sharing a similar view expressed by participant 3 was participant 8 who added that the Department of Basic Education refunds them for transport costs if they have travelled to work-related meetings. She said:

> *'We attend a workshop where they guide us on how to effectively implement teaching and learning and we claim the transport incentives if we have used our private transports to go to the workshop, which is good' (T8)*

On the other hand, Participant 5 was concerned that in the school where she is working there is no orientation, guidance or ongoing support from the School Management Team, more especially when one is a novice or a newly appointed teacher. Instead, one teaches the way they deem suitable. She declared:

> *'In my school no one monitor teachers while implementing formative assessment, as teachers we assess according to our suitability, well we normal use CAPS documents because the SMT don't bother themselves in developing teachers when it comes to assessment, especially when you are newly appointed you need support' (T5)*

Thus, overall internal and external support and guidance from the School Management Team and the Department of Basic Education is limited, more especially with regard to equipping teachers with a thorough understanding of the concepts of formative assessment, its applicability, and the best formative assessment practices in science education. Although some of this support and guidance, including professional teacher development (workshop and cluster meetings) and classroom visits and observation, does attempt to promote the inclusion of formative assessment to enhance learners' understanding, there is still a need for continuous professional development interventions specifically related to the pedagogy of formative assessment in classroom practice. This affirms Santo and Darling-Hammond's (2008) findings that a teacher's skill in assessing learners lies in how deeply he/she understands assessment.

Therefore, there is a need for teachers to receive adequate support and guidance from the SMT and DBE, including continuous, differentiated and tailor-made professional development programmes to suit their context within the Physical Science classroom.

### 4.3 CHAPTER SUMMARY

In this chapter, the collected data were analysed and presented. Findings from the participants on the perspectives of embedding formative assessment in the FET phase were systematically summarised. This study aimed to explore Grade 10 Physical Sciences teachers' perspectives of embedding formative assessment in their classroom practices; ascertain how Grade 10 Physical Science teachers embed formative assessment in their classroom practices; determine the challenges that Grade 10 Physical Science teachers encounter during embedding formative assessment in their classroom practices; and to identify the classroom support and guidance that are available to Grade 10 Physical Science teachers in embedding formative assessment in their classroom practices. Data were collected from 12 teachers through three semi-structured focus group interviews and twelve classroom observations. Responses were analysed and compared to determine the similarities and differences in their responses.

Themes were generated from the transcriptions, presented through extensive analysis, and discussed according to the research questions for the study. The findings revealed that formative assessment plays a fundamental role in enhancing learners' understanding of scientific concepts, and cannot be overlooked in favour of the summative assessment. Given the widespread acceptance of the importance of scientists in society, there is a critical need to integrate formative assessment in the teaching and learning of science into classroom practice and in all subjects offered in schools.

The research findings established that teachers are faced with diverse challenges in implementing formative assessment. Therefore, there is a need for science teachers to be provided with adequate resources and LTSM to support them in the implementation of formative assessment, as well as continuous professional teacher development such as training and workshops on how to effectively integrate formative assessment across the science curriculum in the FET phase. The chapter also revealed that there is a need for teachers to understand formative assessment themselves for easy integration, as well as a need for parents to be more involved with teachers in the integration of formative assessment. The next chapter provides the summary and findings of the study as well as the recommendations for achieving effective formative assessment outcomes.

# CHAPTER FIVE

# SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

## 5.1 INTRODUCTION

This study aimed to explore Grade 10 Physical Science teachers' perspectives on embedding formative assessment in a Physical Science classroom in iSambane Circuit Schools, with the view to promote the inclusion of best assessment practices within a science context. This study was able to explore Grade 10 Physical Science teachers' perspectives of embedding formative assessment in their classroom practice, and ascertained how they were able to accomplish this, determined the challenges that Grade 10 Physical Science teachers encounter during embedding formative assessment in their classroom practices, and identified the classroom support and guidance available to Grade 10 Physical Science teachers in embedding formative assessment in their classroom practices. The findings of this study might be significant to the stakeholders in the education system – the Department of Basic Education, School Management Teams, policymakers and teachers concerning planning, administering and improving formative assessment practices in science education.

This chapter, therefore, presents the summary and conclusions on the key research findings and also highlights recommendations that could be beneficial for further research within the field of formative assessment in science education. The findings of this chapter will be presented under each of the stipulated objectives. The objectives of the study were as follows:

5.1.1 To explore Grade 10 Physical Science teachers' perspectives of embedding formative assessment in their classroom practices.

5.1.2 To ascertain how Grade 10 Physical Science teachers embed formative assessment in their classroom practices.

5.1.3 To determine the challenges that Grade 10 Physical Science teachers' encounter during embedding formative assessment in their classroom practices.

5.1.4 To identify the classroom support and guidance that are available to Grade 10 Physical Science teachers in embedding formative assessment in their classroom practices.

A total of twelve participants participated in this research study. A qualitative approach, with the use of semi-structured focus group interviews and non-participant classroom observations, formed part of data collection. The participants were drawn from high schools from the circuit of Inkosi Sambane as outlined in chapter three (methodology).

## 5.2 SUMMARY OF MAIN FINDINGS AND DISCUSSIONS

The main findings of the study are discussed in this section where they are encapsulated within each of the objectives.

### 5.2.1 To explore Grade 10 Physical science teachers' perspectives of embedding formative assessment in their classroom practice

Participants were asked about their understanding of formative assessment. The purpose was to determine their conceptualisation of this concept such that they can operationalise it in the teaching and learning of science in their classroom practice. The findings from the study have revealed that the majority of the teachers who participated in this study have not well understood the concept of formative assessment. It was also evident that they did not understand how to effectively integrate it into their daily classroom practice.

This implies that there is no deliberate and purposeful inculcation of formative assessment activities by the teachers. Their assessment techniques are implicit rather than explicit. From the findings, it was also evident that the main purpose of science education and teaching was to develop only the learners' cognitive skills to excel in summative assessment for grading purposes. Teachers who do not understand the concept of formative assessment find it extremely difficult to integrate it into their teaching of Physical science.

The findings from this study revealed that the planning of formative assessment in a science classroom is intentionally integrated into the classroom practice of the majority of the participants using various planning sources such as Annual Teaching Plan (ATP), Curriculum and Assessment Policy Statement document as well as the examination guidelines. It is indeed the responsibility of each Physical Science teacher to successfully plan for formative assessment and integrate it into their practice to interact with learners in creating a positive classroom atmosphere for learners to share ideas and express their views through the teaching of Physical science.

Findings also revealed that the integration of formative assessment helps learners to learn from one another; as they work in small groups, they share information guided by the teacher as a more knowledgeable other. Regrettably, some participants boldly alleged that even though the planning of formative assessment in a Physical Science classroom is vital, when they have to integrate it they face challenges such as overcrowded classes and a lack of resources. They also indicated that they sometimes do not relate their implementation of formative assessment to CAPS document due to those challenges, so their teaching does not embrace the aim and principles of the curriculum as set out in CAPS.

Findings revealed that as Physical Science teachers still struggle with a deep understanding of the concept of formative assessment, they might also find difficulty with effective operationalisation, integration and implementation of formative assessment in their classroom practice. According to the literature examined, teachers are the key individuals in integrating and understanding formative assessment so as to meet learners' needs (Wiliam & Leahy, 2007). In the same way, Wiliam (2011) and Keeley (2015) are of the view that formative assessment could bring benefits if teachers fully understand the concept; accordingly, learners thinking can become more explicit during the inquiry.

### 5.2.2 To ascertain how Grade 10 Physical Science teachers embed formative assessment in their classroom practice

One of the questions addressed under this theme was to understand how science teachers embed formative assessment in their classroom to enhance learners' scientific understanding. Findings on the nature of embedding formative assessment indicated that participants employed various methods and strategies to embed formative assessment. Small group discussions, questioning and feedback were amongst the strategies used by teachers while embedding formative assessment. It was noted that participants adopt strategies based on their classroom environment and atmosphere; for instance, participants who embed formative assessment using small group discussions were having less numbers of learners in a classroom, thus it was easy for the teacher to reach out to every group to facilitate learning. Teachers adopted Vygotsky' Socio-cultural theory (1978) which claims that the mind develops through one's interaction with the world or others around him or her. Furthermore, small group discussions in a science classroom make learning not to be an individual activity, but a cognitive activity so that the nature of learning shifts from an individual to interaction within a social context. In that way, those teachers who embed formative assessment using small group discussions were cardinal to the improvement of learners' learning since they construct knowledge through social sharing and interaction.

Provision of regular feedback was another method which some of the participants used while embedding formative assessment in their classroom practice. Feedback has been advocated in several studies for its benefits. For instance, Hyland (2000) mentioned that feedback encourages learners to participate in a classroom activity and makes them less passively teacher-dependent. Some of the teachers were emphatic that science teachers should indeed be patient when providing feedback to their learners since they have varying abilities; some can interpret feedback on their own and make meaning out of it, while others need teacher's guidance to understand the feedback.

The findings also revealed that the manner in which the feedback is provided may vary from oral feedback to written feedback, but both types of feedback provision must meet learners' needs. Yang (2006) also adds that feedback is beneficial in developing critical thinking skill, learners' autonomy and social interaction among learners. More importantly, the findings of this study indicated that feedback allows learners to receive more individual comments and gives teachers an opportunity to practise and develop new strategies to enhance learners' scientific understanding.

Findings on this theme also indicated that questioning was another method adopted by other participants while embedding formative assessment in their science classroom practices. One of the participants cited as an example that teaching science must have a starting point, and to find that starting point, you have to know learners' understanding first, which is prior knowledge. Participants who were sampled in this study viewed questioning as an important method only if it enhances learners' understanding. However, the majority of the questions asked by participants mainly focused on recalling and remembering, lower-order thinking and a minority stimulated critical thinking during the Physical Science lesson. Questions must be pitched at all levels of Blooms' taxonomy, not just merely recalling or understanding. This is affirmed by Myhill and Dunkin (2007) who indicate that when a teacher employs questioning as a teaching strategy during formative assessment in a science classroom, the relationship between the type of question and the type of response is significant in developing learners' understanding of concepts.

### 5.2.3 To determine the challenges that Grade 10 Physical Science teachers' encounter during embedding formative assessment in their classroom practices

The findings indicate that the majority of the participants encounter challenges while implementing formative assessment and those challenges negatively impact science learning in the classroom practices such that science teachers fail to embrace certain concepts correctly. Participants kept on mentioning the challenges they encounter while embedding formative assessment in a science classroom, but no solutions were suggested.

Findings revealed that there is a need for professional teacher development on the integration of formative assessment. Science teachers need to comprehend what formative assessment is, how it should be embedded and why it should be integrated into their classroom practice. Therefore, for this to happen, it is also essential that workshops and cluster meetings are provided for the science teachers to be trained on the importance of formative assessment integration into the classroom practices. Findings further indicated that professional teacher development is needed by the science teachers to support and develop them on how to integrate formative assessment in science education regardless of an overcrowded classroom, lack of resources as well as inadequate LTSM; moreover, there is a need to re-orientate science teachers who believe that summative assessment is more important than formative assessment. The professional teacher development programmes will enhance teachers' ability to endow learners with intellectual skills and knowledge.

The findings showed that teachers encounter several challenges in the implementation of formative assessment in the FET phase. Teachers revealed that they struggle in teaching sciences because they lack resources, they cannot access Learner-Teacher Support Materials (LTSMs), classrooms are overcrowded, the language of learning and teaching (LoLT) poses a challenge to learners, Physical Science has a reputation as a 'Hard subject', and there is a lack of parental involvement and support. Participants indicated that the Department of Basic Education merely concentrates on increasing the pass rates in Grade 12, instead of assisting science teachers on developing strategies that they can employ in the classroom to effectively embed formative assessment to improve learners' understanding of the subject.

Findings also revealed that most rural-based parents are illiterate, and they are not exposed to education issues. For instance, one of the participants complained that a challenge they are experiencing is that when they give learners work to do at home, parents do not play their part because of the lack of knowledge and that becomes a challenge to them as teachers because education consists of three pillars: the teacher, the learner and the parent.

Participants also indicated that other challenges to the implementation of formative assessment are the availability, accessibility and suitability of learner-teacher support materials such as science textbooks and scientific calculators to perform calculations as basic skills in Physical Science. Implementing a formative assessment in such an environment becomes difficult, if not impossible. The majority of the participants emphasised the importance of embedding formative assessment in a science classroom practice in shaping their learners to conform with society needs of post-schooling, but indicated that there is a need for parents to support the classroom activity of embedding formative assessment to the learners and thus the Department of Basic Education has to play a major role in reducing the challenges mentioned by Physical Science teachers.

### 5.2.4 To identify the classroom support and guidance that are available to Grade 10 Physical Science teachers in embedding formative assessment in their classroom practices

The purpose of this theme was to identify the support and guidance available for science teachers in implementing formative assessment in their classroom practices, both internal and external. Findings from this study revealed that external support Physical Science teachers receive are training workshop and professional development programs from the Department of Basic Education. Participants indicated that even though they attend training workshops, not much information provided during the training workshops focuses on the incorporation and implementation of formative assessment in a Physical Science classroom. Carl (2012) affirm that teachers can implement assessment successfully only if they receive adequate and suitable training directed towards their classroom practice and needs. Other participants indicated that the kind of workshops they attend are too short and there are no follow up sessions, thus making the support futile.

Professional development was amongst the external support initiatives science teachers receive with regard to the implementation of formative assessment. The majority of participants confirmed that little professional development is in place to support them in incorporating the best formative assessment strategies. Furthermore, participants in this study viewed ongoing professional development as the best support and guidance that assists science teachers to better embed formative assessment; this is supported by Kelly (2009) who argue that no curriculum change and adaption is effective if the professional development of teachers is not in place.

Findings also indicated that science teachers receive the support and guidance, internally, which only included maintaining learner discipline by the SMT, classroom visits and monitoring with no emphasis on the integration of formative assessment in the teaching of Physical Science. The South Africa’s Department of Basic Education has explicitly stipulated that the SMT support in the implementation of formative and summative assessment would be critical for the success of the learners and novice teachers, however, maintaining learner discipline must be an ongoing process. One of the participants affirmed that classroom visits by SMT to maintain learner discipline while integrating formative assessment is essential, especially when the class size is large because if there is no discipline there will be no productive teaching and learning. Marais (2016) affirmed that teachers in large class sizes find it difficult to provide conducive and productive teaching and learning classroom atmosphere, thus the need to be supported in the implementation of formative assessment.

Physical Science teachers receive access to learner teacher support materials as internal support while implementing formative assessment. It was noted during semi-structured focus group interviews that schools at Inkosi Sambane Circuit are from deep rural areas with little resources, however, participants indicated that their HODs try by all means to access the little resources they can, such as textbooks, workbooks, chemicals and apparatus to perform experiments while teaching and learning of science is in place. Agbadzi (2009) states that learner teacher support materials create a visual impression on the learners during the instruction, enhancing comprehension of the content presented to them during the inquiry, thus supporting the teaching of science.

## 5.3 DISCUSSION OF THE FINDINGS IN RELATION TO THE THEORETICAL FRAMEWORK

As discussed in Chapter 2, the Socio-Cultural Theory was adopted in this study. The adoption of Socio-cultural theory helped in understanding the key findings of the study. The study found that proper implementation of formative assessment in the classroom practice and where resources are adequate may help learners to enhance scientific and conceptual understanding. The pioneers of the Socio-Cultural Theory believe that learning takes place in a social setting where the more knowledgeable person guides and scaffolds those with less understanding about a certain phenomenon around them.

The adoption of Socio-Cultural Theory also helped in accomplishing the main aim of the study, which was to explore Grade 10 Physical Science teachers' perspectives on embedding formative assessment in a Physical Science classroom in Inkosi Sambane Circuit Schools, with the view to promote the inclusion of the best assessment practices within a science context. Through the use of Socio-Cultural Theory which advocates that the classroom environment influences learners' growth and understanding through formative assessment, the study also found that formative assessment as an instructional method enables learners to move from the known to the abstract in a form of Zones of Proximal Development (ZPD). It can be concluded that the Socio-Cultural Theory was relevant to the study.

**5.4 CONCLUSIONS**

The main aim of the study was to explore teachers' perspectives on embedding formative assessment to provide best practices of assessment in a science classroom. It was revealed in this study that most of Grade 10 Physical Science teachers who were sampled in this study embed formative assessment with little or fewer resources in their classroom practices. Formative assessment may be a powerful tool in the teaching and learning of science that can influence the learners' understanding of concepts and scientific operations; hence formative assessment must be given equal attention as summative assessment in educational practice. Moreover, it appeared in this study that the professional teacher development provided by the Department of Basic Education is not specifically focusing on formative assessment but rather on summative assessment. It is then concluded that formative assessment implementation in teaching Grade 10 Physical Science may assist in laying a good foundation for the teaching and learning of science

Although the study was limited to twelve high schools of Inkosi Sambane Circuit, findings from semi-structured focus group interviews and non-participant classroom observation revealed the gap between policymakers and science teachers. This gap is associated with the teachers' lack of understanding of the concept of formative assessment in science classroom practices. From the responses given in the interviews with the participants, it was clear that some of them did not even understand the concept of formative assessment. As a result, they could not integrate what they did not know. It was also clear that for them, the main purpose of education and teaching science was to develop only the cognitive domain of learners. They were not even certain if they follow the assessment guidelines from the CAPS document, which specifies deliberate and intentional in preparation of learners with knowledge, information, skills and attitudes through formative assessment. Science teachers must be involved in curriculum planning and development. This will enable them to develop insight into the understanding of the science curriculum and assessment practices so these may be effectively implemented into their classroom practice.

## 5.5 RECOMMENDATIONS

The following recommendations were made based on the literature and empirical study conducted. The motivation for conducting the study was given in Chapter 3. The study aimed to explore teachers' perspective on embedding formative assessment in their classroom practices.

Based on the research findings, the following recommendations were made:

- Existing research studies on embedding formative assessment in South African schools indicate that there is a literature gap, hence there is a need for more research to be done to improve the integration of formative assessment in science education in South African schools.
- Existing policies on formative assessment in science education in schools need to be reviewed by curriculum specialists in the Department of Basic Education, with a focus on appropriate measures that can promote effective integration of formative assessment in Physical Sciences in the FET phase.
- The Department of Basic Education should provide regular, relevant and adequate training for Physical Science teachers on pedagogical content knowledge of formative assessment to enhance effective assessment integration in their teaching practice.
- Physical Science teachers also need to be involved in the design of curriculum content for formative assessment. Their involvement will assist in the inclusion of practicable formative assessment strategies that can be integrated into classroom practice.
- There is a need for the school management teams, science teachers and parents to work together to integrate formative assessment. Parents should not disconnect or isolate themselves or shift the responsibility of integrating formative assessment to the teachers for. Parents should support the culture of teaching and learning.

- It is recommended that Physical Science teachers deliberately integrate formative assessment in classroom practice and ensure that learners' scientific understanding is enhanced to assist them beyond the school environment. There is a strong belief that science can transform society in this 21st century.
- The classroom environment can either promote or hamper the implementation of formative assessment for learners. It is therefore suggested that Physical Science teachers and school management teams create a classroom environment that will be conducive to the teaching and learning of science.
- It is suggested that both pre-service and in-service science teachers be exposed to and explicitly groomed in various formative assessment strategies that can be employed in a science classroom.

## 5.6 RECOMMENDATION FOR FUTURE RESEARCH

Findings from this study raised several questions that could guide future studies. This study found that formative assessment is still a challenge in terms of conceptualisation and integration. The study recommends that future research should focus on investigating strategies for embedding formative assessment in other subjects and grades. The study also recommends that future studies should increase the sample of participants so that other findings could be more generalisable compared to this study. It is also recommended that future studies should investigate the views of learners on the implementation of formative assessment in the classroom to achieve learning outcomes. This is because learners are the main recipients of formative assessment during teaching and learning.

## 5.7 LIMITATION OF THE RESEARCH

The objectives of this study were achieved but there were some limitations to the study. It was limited to only 12 Grade 10 Physical Science teachers from twelve high schools, and a purposive sampling method was used to select only a small sample of participants for the interviews and classroom observations. Therefore, the findings cannot be generalised to all South African Grade 10 Physical Science teachers. Despite these limitations, the study was able to collect sufficient and valid data using semi-structured focus group interviews with Grade 10 Physical Science teachers, and twelve lessons per school were observed.

This study focused on the high schools in the rural area of Northern KwaZulu-Natal, thus findings cannot be generalised for the whole country. Further studies on the issue in other rural, urban or semi-urban areas of the country would complement this study and serve as evidence of practice across the rural areas and outside. More in-depth studies are needed into formative assessment to improve the embedding of formative assessment in schools for all subjects. Parental involvement to complement the schools' efforts is also needed. Also, the provision of adequate resources in teaching science is vital to enhance learners' scientific understanding.

## 5.8 CHAPTER SUMMARY

This chapter summarised and concluded the research findings, and presented the appropriate recommendations for the integration of formative assessment in science education in Grade 10. The objectives of the study were to explore Grade 10 Physical Science teachers' perspectives of embedding formative assessment in their classroom practice; to ascertain how Grade 10 Physical Science teachers embed formative assessment in their classroom practices; to determine the challenge that Grade 10 Physical Science teachers' encounter during embedding formative assessment in their classroom practice, and to identify the classroom support and guidance that is available to Grade 10 Physical Science teachers in embedding formative assessment in their classroom practice.

The key findings revealed that formative assessment was being integrated explicitly by some Grade 10 Physical Science teachers, while others did not understand the concept of formative assessment, hence they could not effectively integrate it. Parental involvement in embedding formative assessment is important, while resources (material and physical), learner teacher support materials and language of learning and teaching were seen as important vessels for integration of formative assessment in classroom practice. Appropriate, adequate and regular science teacher training in essentials of embedding formative assessment, including its pedagogical content knowledge, should be effectively structured for science teachers. The findings also indicated that formative assessment should be given equal attention across all subjects offered in the South African curriculum, it should not be subject-specific.

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## APPENDIX A: SEMI-STRUCTURED FOCUS GROUP INTERVIEWS

### Theme 1: Teachers' perspectives on embedding formative assessment in their classroom practices

(a) What is your understanding about using formative assessment in a science classroom?

(b) How do you actually plan for formative assessment in your science lessons?

(c) Explain the different important elements you take into consideration during the process of integrating formative assessment so that you enhance learners understanding in your science classroom.

### Theme 2: Embedding formative assessment in their classroom practice

(a) Tell us how you use formative assessment during your science lessons?

(b) How do you provide feedback to your learners?

### Theme 3: Challenges that Grade 10 Physical Science teachers' encounter during embedding formative assessment in their classroom practice

(a) What challenges do you encounter when you use formative assessment in your classroom practice?

### Theme 4: Classroom support and guidance that is available to Grade 10 Physical Science teachers in embedding formative assessment

(a) What classroom support and guidance is available to assist you to implement formative assessment in your science classroom (Internal and External)

## APPENDIX B- NON-PARTCIPANT CLASSROOM OBSERVATIONS

**Objective: Ascertain how Grade 10 Physical Science teachers embed formative assessment in their classroom practice.**

| SUBJECT | | DURATION | |
|---|---|---|---|
| DATE | | NUMBER OF LEARNERS | |

| ASPECTS OBSERVED DURING ASSESSMENT PRACTICES | COMMENTS/OBSERVATION |
|---|---|
| 1. Is the lesson presented in line with the lesson plan?<br>a. Are the lesson outcomes aligned to the Curriculum and Assessment Policy Statement for Grade 10?<br>b. Are the different stages clearly articulated in the lesson plan? | |
| 2. Does the teacher clearly state the learning outcomes at the beginning of the lesson? | |
| 3. Are the assessment strategies appropriate?<br>a. Methods<br>b. Tools<br>c. Techniques | |
| 4. Does the teacher make use of varied instruction strategies to meet the learner's needs in the classroom? (guiding instruction)<br>a. Predict-Explain-Observe (P-E-O) strategy<br>b. Cards Sort Strategy<br>c. Concept Cartoons<br>d. Questioning<br>e. Peer assessment<br>f. Formative use of summative assessment | |
| 5. Does the teacher use of varied approaches to assess learners understanding? (learners learning) | |

| | |
|---|---|
| a. Do learners possess misconceptions while teacher integrates formative assessment?<br>b. How does the teacher identify the gaps in learners learning?<br>c. Is the teacher able to effectively scaffold and guide the learners during the learning process? | |
| 6. Does the teacher provide an opportunity for active involvement and engagement of learners in the learning process? | |
| 7. Does the teacher provide appropriate feedback to the learners?<br>a. Is this feedback specific to the activity that the learners are doing?<br>b. Does this feedback prompt the learners to move forward (feedforward)?<br>c. Are the learners able to interpret feedback from the teacher about their learning? | |
| 8. How does the teacher incorporate resources during the process of embedding formative assessment? (LTSM) | |
| 9. Is the time allocation per lesson sufficient enough for the teacher to accommodate formative assessment? | |
| 10. Is there a well-established classroom culture that encourages interaction for teacher to use formative assessment effectively? | |
| **ADDITIONAL OBSERVATIONS** | |

**APPENDIX C**

University of Zululand
Faculty of education
Private Bag X1001
KwaDlangezwa
Empangeni
3886
15 August 2020

The Circuit Manager
Department of Basic Education
Inkosi Sambane Circuit
KwaZulu Natal

Dear Sir/Madam

**REF: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN SCHOOLS**

I am employed by the Department of Basic Education and currently teaching at a Secondary school. I am currently registered for a Master of Education degree (M. Ed.) at the University of Zululand within the department of Mathematics, Science and Technology. The topic of my research project is**: Teacher's perspectives on embedding formative assessment in Grade 10 Physical Sciences at Inkosi Sambane Circuit Schools**

I wish to seek permission to conduct research in schools under UMkhanyakude district in the Inkosi Sambane circuit. The educators who teach Grade 10 who are currently involved in teaching Physical sciences will be used as participants to collect data for the study. The researcher will conduct semi -structured focus group interviews and non-participant observations as a data collection method. The researcher will seek permission from the principals, then schedule an appointment with the teachers, during their lunch breaks and/or even after school, to minimize disturbance of the functionality of the school.

I hope the findings of this study will benefit and assist the Department of Basic Education and educators teaching in Secondary Schools

Yours faithfully

-----------------------------

Mr Halalisani Mngomezulu

072 431 2996 or email: makwempe@gmail.com

Dr Samanth Govender (Supervisor) Dr T.W Chinaka (Co-Supervisor)

**APPENDIX D**

University of Zululand
Faculty of education
Private Bag X1001
KwaDlangezwa
Empangeni
3886
15 August 2020

The Principal

Dear Sir/Madam

**REF: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN SCHOOLS**

I am employed by the Department of Basic Education and currently teaching at a Secondary school. I am currently registered for a Master of Education degree (M. Ed.) at the University of Zululand within the department of Mathematics, Science and Technology. The topic of my research project is**: Teacher's perspectives on embedding formative assessment in Grade 10 Physical Sciences at Inkosi Sambane Circuit Schools**

I cordially request for permission to conduct research in your school. The educators who teach Grade 10 who are currently involved in teaching Physical Sciences will be used as participants to collect data for the study. The researcher will conduct semi - structured focus group interviews and non-participant observations as a data collection method. The researcher will schedule convenient times with the selected teachers to conduct interviews and observations. Kindly take note that I shall conduct the interviews during their lunch breaks and/or even after school, to minimize disturbance of the functionality of the school.

I hope the findings of this study will benefit and assist the Department of Basic Education and educators teaching in Secondary Schools.

Yours faithfully

-----------------------------

Mr Halalisani Mngomezulu

072 431 2996 or email: makwempe@gmail.com

Dr Samantha Govender (Supervisor) Dr T.W Chinaka (Co-Supervisor)

**APPENDIX E**
**PARTICIPANT INFORMED CONSENT DECLARATION**

**INFORMED CONSENT DECLARATION**
**(Participant- Educators) (SEMI-STRUCTURED FOCUS GROUP INTERVIEWS)**

**<u>Project Title</u>: Exploring Teacher's perspectives on embedding formative assessment in Grade 10 Physical Sciences at Inkosi Sambane Circuit Schools**

The researcher is registered for the Master of Education (M.Ed.) degree at the University of Zululand, Department of Mathematics, Science and Technology.

The nature and the purpose of the research project and of this informed consent declaration have been explained to me in a language that I understand.
I am aware that:

1. The purpose of the research project is to explore teacher's perspectives towards embedding formative assessment in Grade 10 Physical Sciences in the Inkosi Sambane Circuit Schools

2. The University of Zululand has given ethical clearance to this research project and I have seen/ may request to see the clearance certificate.

3. By participating in this research project I will be contributing towards improving the nature of embedding formative assessment in my classroom practice, specifically Grade 10 Physical Sciences.

4. I will participate in the project by answering questions in a semi-structured focus group interview regarding my perspectives, challenging and the nature of classroom support and guidance that is available regarding embedding formative assessment in my classroom practice in Physical Sciences in Grade 10 at Inkosi Sambane Circuit Schools.

5. My participation is entirely voluntary and should I at any stage wish to withdraw from participating further, I may do so without any negative consequences.

6. I will not be compensated for participating in the research, but my out-of-pocket expenses will be reimbursed.

7. There may be risks associated with my participation in the project. I am aware that

a. the following risks are associated with my participation: information disclosure and identification of the participants
b. the following steps have been taken to prevent the risks: consideration of ethical issues.
c. there is no chance of the risk materialising.

8. The researcher intends publishing the research results in the form of journal article and forwarding them to the Department of Basic Education. However, confidentiality and anonymity of records will be maintained and that my name and identity will not be revealed to anyone who has not been involved in the conduct of the research.
9. I will receive feedback in the form of empirical findings and access to the copy of this report regarding the results obtained during the study.

10. Any further questions that I might have concerning the research or my participation will be answered by on the following mobile number Mr Halalisani Mngomezulu on the following mobile number: 0724312996 or email: makwempe@gmail.com

11. By signing this informed consent declaration I am not waiving any legal claims, rights or remedies.

12. A copy of this informed consent declaration will be given to me, and the original will be kept on record.

I, ………………………………………………………have read the above information/ confirm that the above information has been explained to me in a language that I understand and I am aware of this document's contents. I have asked all questions that I wished to ask and these have been answered to my satisfaction. I fully understand what is expected of me during the research.

I have not been pressurised in any way and I voluntarily agree to participate in the above-mentioned project.

…………………………………. …………………………………….

**Participant's signature** **Date**

**APPENDIX F**
**PARTICIPANT INFORMED CONSENT DECLARATION**

**INFORMED CONSENT DECLARATION**
**(Participant- Educators) (NON PARTICIPANT CLASSROOM OBSERVATION SCHEDULE)**

**<u>Project Title</u>: Teacher's perspectives on embedding formative assessment in Grade 10 Physical Sciences at Inkosi Sambane Circuit Schools**

The researcher is registered for the Master of Education (M.Ed.) degree at the University of Zululand, Department of Mathematics, Science and Technology.

The nature and the purpose of the research project and of this informed consent declaration have been explained to me in a language that I understand.
I am aware that:

1. The purpose of the research project is to explore teacher's perspectives towards embedding formative assessment in Grade 10 Physical Sciences in the Inkosi Sambane Circuit Schools

2. The University of Zululand has given ethical clearance to this research project and I have seen/ may request to see the clearance certificate.

3. By participating in this research project I will be contributing towards improving the nature of embedding formative assessment in my classroom practice, specifically Grade 10 Physical Sciences.

4. I will participate in the project by granting the researcher permission to observe my lesson, specifically the nature of embedding formative assessment in my classroom practice in Physical Sciences in Grade 10 at Inkosi Sambane Circuit Schools.

5. My participation is entirely voluntary and should I at any stage wish to withdraw from participating further, I may do so without any negative consequences.

6. I will not be compensated for participating in the research, but my out-of-pocket expenses will be reimbursed.

7. There may be risks associated with my participation in the project. I am aware that

a. the following risks are associated with my participation: information disclosure and identification of the participants
b. the following steps have been taken to prevent the risks: consideration of ethical issues.
c. there is no chance of the risk materialising.

8. The researcher intends publishing the research results in the form of journal article and forwarding them to the Department of Basic Education. However, confidentiality

and anonymity of records will be maintained and that my name and identity will not be revealed to anyone who has not been involved in the conduct of the research.

9. I will receive feedback in the form of empirical findings and access to the copy of this report regarding the results obtained during the study.

10. Any further questions that I might have concerning the research or my participation will be answered by on the following mobile number Mr Halalisani Mngomezulu on the following mobile number: 0724312996 or email: makwempe@gmail.com

11. By signing this informed consent declaration I am not waiving any legal claims, rights or remedies.

12. A copy of this informed consent declaration will be given to me, and the original will be kept on record.

I, ……………………………………………………………have read the above information/ confirm that the above information has been explained to me in a language that I understand and I am aware of this document's contents. I have asked all questions that I wished to ask and these have been answered to my satisfaction. I fully understand what is expected of me during the research.

I have not been pressurised in any way and I voluntarily agree to participate in the above-mentioned project.

…………………………………. …………………………………….

**Participant's signature** **Date**

# APPENDIX G: ETHICAL CLEARANCE CERTIFICATE

**UNIVERSITY OF ZULULAND**
**RESEARCH ETHICS COMMITTEE**
(Reg No: UZREC 171110-030)

**RESEARCH & INNOVATION**
Website: http://www.unizulu.ac.za
Private Bag X1001
KwaDlangezwa 3886
Tel: 035 902 6731
Fax: 035 902 6222
Email: LundallN@unizulu.ac.za

## ETHICAL CLEARANCE CERTIFICATE

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Certificate Number** | **UZREC 171110-030 PGM 2019/128** | | | | | | | |
| **Project Title** | **Teachers' perspective on embedding formative assessment in Grade 10 Physical Sciences at Inkosi Sambane Circuit schools** | | | | | | | |
| **Principal Researcher/ Investigator** | H Mngomezulu | | | | | | | |
| **Supervisor and Co-supervisor** | Dr Samantha Govender | | | | Dr TW Chinaka | | | |
| **Department** | Mathematics Science and Technology Education | | | | | | | |
| **Faculty** | Education | | | | | | | |
| **Type of Risk** | Med Risk – Data collection from people | | | | | | | |
| **Nature of Project** | Honours/4th Year | | **Master's** | x | Doctoral | | Departmental | |

The University of Zululand's Research Ethics Committee (UZREC) hereby gives ethical approval in respect of the undertakings contained in the above-mentioned project. The Researcher may therefore commence with data collection as from the date of this Certificate, using the certificate number indicated above.

Special conditions:

**(1) This certificate is valid for 1 year from the date of issue.**
**(2) Principal researcher must provide an annual report to the UZREC in the prescribed format [due date-29 June 2021]**
**(3) Principal researcher must submit a report at the end of project in respect of ethical compliance.**
**(4) The UZREC must be informed immediately of any material change in the conditions or undertakings mentioned in the documents that were presented to the meeting.**

The UZREC wishes the researcher well in conducting research.

**Professor Mashupye R. Kgaphola**
**Acting Chairperson: University Research Ethics Committee**
**Deputy Vice-Chancellor: Research & Innovation**

**29 June 2020**

CHAIRPERSON
UNIVERSITY OF ZULULAND RESEARCH ETHICS COMMITTEE (UZREC)
REG NO: UZREC 171110-30
29 -06- 2020
RESEARCH & INNOVATION OFFICE

## APPENDIX H: PERMISSION GRANTED TO CONDUCT RESEARCH (KZN DoE)

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

| Enquiries: Phindile Duma | Tel: 033 392 1063 | Ref.:2/4/8/2034 |
|---|---|---|

Mr H Mngomezulu
PO Box 439
Jozini
3969

Dear Mr Mngomezulu

**PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS**

Your application to conduct research entitled: **"TEACHER'S PERSPECTIVES TOWARDS EMBEDDING FORMATIVE ASSESSMENT IN GRADE 10 PHYSICAL SCIENCES AT INKOSI SAMBANE CIRCUIT SCHOOLS",** in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 07 October 2019 to 01 March 2022.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

UMkhanyakude District

Nzama

**Dr. EV Nzama**
**Head of Department: Education**
**Date: 08 October 2019**

...Championing Quality Education - Creating and Securing a Brighter Future

**KWAZULU-NATAL DEPARTMENT OF EDUCATION**
**Postal Address:** Private Bag X9137 • Pietermaritzburg • 3200 • Republic of South Africa
**Physical Address:** 247 Burger Street • Anton Lembede Building • Pietermaritzburg • 3201
**Tel.:** +27 33 392 1063 • **Fax.:** +27 033 392 1203• **Email:**Phindile.Duma@kzndoe.gov.za •**Web:**www.kzneducation.gov.za
Facebook: KZNDOE....Twitter: @DBE_KZN....Instagram: kzn_education....Youtube:kzndoe

## APPENDIX I: EDITORIAL CERTIFICATE

# EDITORIAL CERTIFICATE

This document certifies that the **dissertation** listed below was edited for proper English language, grammar, punctuation, spelling, and overall style by

Dr KA Gazu
Department of Arts and Languages Education
GazuK@unizulu.ac.za

**Title of the Manuscript**

**TEACHERS' PERSPECTIVES ON EMBEDDING FORMATIVE ASSESSMENT IN GRADE 10 PHYSICAL SCIENCES AT INKOSI SAMBANE CIRCUIT SCHOOLS**

**BY**

**HALALISANI MNGOMEZULU**

**Student Number: 201231318**

Signed 06.03.2021

**APPENDIX J: PLAGIARISM REPORT**

TEACHERS' PERSPECTIVES ON EMBEDDING FORMATIVE ASSESSMENT IN GRADE 10 PHYSICAL SCIENCES AT INKOSI SAMBANE CIRCUIT SCHOOLS

ORIGINALITY REPORT

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