An exploration of grade 4 teachers' understanding and practice of formative assessment in Mathematics.

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DECLARATION

I, Jacob Mark Anthony Tri, hereby declare that this research report titled *An exploration of grade 4 teachers' understanding and practice of formative assessment in Mathematics*, is my own work, and that it has not been submitted for any degree or examination to any other University. I declare that all the sources I have used or quoted have been referenced and acknowledged.

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Date: 15 March 2024.

ABSTRACT

This qualitative case study examined grade 4 teachers' understanding and implementation of formative assessment in mathematics at a South African private school. The study employed semi-structured interviews with three teachers and observations of nine lessons to develop insights into how educators conceptualize and apply formative assessment strategies.

Thematic analysis revealed that while teachers demonstrated strong theoretical knowledge of formative assessment during interviews, classroom practices showed inconsistencies and missed opportunities for effective integration. Key findings indicated gaps in translating conceptual understanding into consistent, high-quality formative routines. Instruction often conflated formative and summative purposes, with an over-reliance on teacher judgments rather than eliciting student thinking. Despite recognizing the value of descriptive feedback, crucial opportunities were missed to provide specific guidance to advance learners' mathematical comprehension.

Challenges in implementing formative assessment stemmed from time constraints, difficulties managing differentiation, and determining appropriate pedagogical responses based on assessment insights. The overarching issue was the struggle to operationalize theoretical understanding into routines that unveil and responsively scaffold students' emerging mathematical proficiencies.

The study highlights the need for ongoing professional development, collaborative planning, and coaching to bridge the theory-practice divide. Leveraging technology and resources could alleviate logistical constraints. Recommendations aim to foster a culture of continuous learning and responsiveness to students' evolving needs. Effective formative assessment has the potential to enhance engagement, conceptual understanding, and achievement in mathematics.

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ACRONYMS & ABBREVIATIONS.

CAPS –Curriculum and Assessment Policy Statement

DBE- Department of Basic Education

OBE- Outcomes Based Education

C2005- Curriculum 2005

RNCS- Revised National Curriculum Statement

DOE- Department of Education

IEB - Independent Examinations Board (IEB)

ISASA- Independent Schools Association of Southern Africa

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CHAPTER ONE

ORIENTATION TO THE STUDY

1.1 Introduction

The goal of this research was to understand the perceptions and practices of grade 4 teachers in the context of formative assessment, specifically in the mathematics learning area at a private school in Gauteng province. This introductory chapter aimed to orient the reader to the study by providing background information, contextualising it, and discussing the key concepts relevant to this study. This chapter included the problem statement, research objectives, key research questions, research methodology, and study structure. The chapter concluded by providing an outline of the chapter that follows.

1.2 Background and contextualisation of study

Until 1994, the focus of the South African educational system was on summative assessment through tests and examinations. Assessment was different from pedagogy, in that it assessed discrete, isolated or fragmented "knowledge" and "skills" (Lubisi, 1999). As a result, teaching, learning and assessment were viewed as separate activities, such that teachers did not consider assessment until after they had taught everything. Traditional, testing-based assessment practices came under heavy criticism, for not emphasising higher-order thinking skills, or valuing the learners' contributions (Lubisi, 1999, Andrade, 2010). Primary school mathematics also used summative assessment. The grading and ranking of students in class mainly utilised mathematics assessments. This meant that this type of assessment was regularly done through tests and examinations. Many teachers considered it important for pupils to memorise formulas as the chief aim in primary school mathematics because it was largely viewed as a subject where rote memory of formulae instead of conceptual understanding was key. Critics attacked the traditional method of teaching mathematics because it was excessively prescriptive, algorithmic, and memory-dependent (Lubisi, 1999, Andrade, 2010).

After 1994, the thinking of assessment had to change. Scholars had opposed calls for increased standardised testing in primary school mathematics with research on models that integrate assessment seamlessly within everyday pedagogy (Andrade, 2010). In this regard, Black and Wiliam (2003) asserted that if assessment is tied to learning, then assessment becomes more powerful than if it were mainly for accountability. This idea of "assessment for learning" formed the basis of what current scholars refer to as formative assessment thus assessment with

prospects that inform and shape teaching and learning in time (Bennett, 2011). Unlike summative testing which evaluates achievement at the end of pedagogy, formative assessment provides real-time insight into student thinking that allows teachers to identify and respond to gaps in understanding (Earl, 2013). Embedded interactively within pedagogy, it functions as a rich feedback mechanism for both learners and teachers, illuminating progress towards goals (Andrade, 2010).

Researchers emphasised that motivating students as self-regulated learners analysing their thinking via metacognitive self-assessment enhances motivation and autonomy (Clark, 2012). Scholars argue for teachers to adopt formative assessment strategies that provide windows into students' thinking, such as rich questioning, facilitating explanations of problem-solving processes, and other techniques revealing student reasoning. This focus echoes calls for reforming rigid initiation-response-evaluation dialogue patterns that limit insights into mathematical understanding (Emanuelsson & Sahlström, 2008). Overall, research resoundingly critiques assessing primary students through fact-based tests alone without dynamic assessment facilitating deeper learning. Progress relies on assessments that activate higher-order cognition and inform pedagogy responsive to demonstrated understanding, not just scores (Emanuelsson & Sahlström, 2008).

The idea of a vision in terms of assessment being an essential part of learning rather than just as a tool for accountability has been the basis of South Africa's curriculum adjustments since apartheid. In 1997, the introduction of Curriculum 2005 saw it advocating for continuous assessment, to be used formatively as part of OBE principles (Chisholm, 2005). The notion that assessment is intricately tied to how teachers teach and not only about holding learners accountable is at the heart of Curriculum 2005 (Chisholm, 2005). Curriculum 2005 (C2005) ambitiously promoted learner-centred education oriented towards competency development rather than rote learning (Jansen, 1999). It endorsed continuous assessment embedded within classroom activities to promote meaningful learning aligned to outcomes (Department of Education, 1997). This vision resonated philosophically with shifting global assessment perspectives centred on "assessment for learning" models (Kellaghan & Greaney, 2001). However, scholars highlight that C2005 adoption was severely constrained by a lack of teacher preparation and capacity building (Jansen & Taylor, 2003; Kanjee & Moloi, 2014). Teachers struggled to shift from deeply embedded notions of assessment as mainly periodic grading through formal examinations. Envisioned classroom-based assessments demanded conceptual and technical shifts that simply failed to materialise at scale (Lubisi & Murphy, 2002).

In 2002, the following revised National Curriculum Statement (RNCS), however, continued to advocate for formative assessment embedded in classroom activities rather than predominantly summative examinations (Department of Education, 2002). This is built on philosophical convergence with emergent global views on fluid modes of 'assessment for learning' and not only 'assessment of learning' (Kellaghan & Greaney, 2001). Yet, academic scholars emphasise that policy rhetoric was swifter than the real transformation of pedagogical processes in classrooms (Jansen, 1999).

Fleisch (2008) argued that without fundamental shifts in educator concepts and competencies around classroom-based assessment, well-intentioned reforms made little headway in transforming entrenched assessment cultures. Despite curriculum vision statements, prevailing mindsets continued focusing assessment on periodic grading and promoting learners based on grades (Kanjee & Moloi, 2014). Teachers lacked strategies for integrating interactive formative assessment strategies as a seamless teaching-learning process centred on advancing understanding (Suurtamm & Koch, 2014). Scholars like Lubisi and Murphy (2002) suggested infrastructure barriers like large class sizes and limited resources also constrained the enactment of continuous assessment. However, underlying issues of teacher capacity and the need to reshape beliefs and practice persisted as the deepest challenges (Jansen & Taylor, 2003; Dunne et al., 2010). Without addressing these root factors, Fleisch (2008) argued that top-down assessment policy reforms had floundered in permeating classroom change.

The Curriculum and Assessment Policy Statement (CAPS) reiterated the importance of formative assessment as a fundamental classroom procedure (DBE, 2011). Introduced in South Africa in 2011, the CAPS curriculum took note of the shift in global assessment perspectives, with models that favour a deeper connection to pedagogy. The vision of CAPS diverged from a narrow concentration on periodical grading and classifications based on end-of-term examinations (DBE, 2011). Instead, CAPS suggests that assessments should become an integral, frequent component of the education and development process. CAPS underscores the significance of formative assessment in mathematics at primary school level. It suggests that teachers use informal, day-to-day checks that are diverse to help them determine their learners' engagement with content, identify learning gaps, and enhance pedagogical practices. Some examples of formative assessments include "classroom discussions, oral questions, mini classroom quizzes, homework exercises, and feedback on practical tasks" (DBE, 2011, p. 4). The policy advises teachers to use assessment to "identify problems and misconceptions early, rather than just issuing marks" (DBE, 2011, p. 5). It also suggests giving learners "second

chances and allowing them to learn from their mistakes" (DBE, 2011, p. 5). Teachers can adapt their teaching and provide help to learners who are not doing well by using formative assessments. The incorporation of formative assessment in CAPS has the goal of improving mathematics learning by making teaching more adaptive to learner demands. As far as the conceptualisation and role of classroom-based assessment were concerned, this was a significant policy shift at the level of curriculum development in South Africa through CAPS. The document states that rather than being thought about as distinct things, assessment and teaching must be seen as one and thus woven together with formative assessment practices as guiding principles towards understanding and implementing curriculum expectations.

However, while policies and curricula have advanced, actual changes in teachers' classroom assessment practices have often been very gradual and uneven across different schooling contexts in South Africa. After 1994, two different types of schools came into existence because of historical and socio-political factors; public and private ones. These groupings were established to cater for the diverse requirements of the population while still recognising inequalities of the past. Sapire and Sorto (2018) and Dhurumraj (2013) found that assessment methods in many public township and rural schools remain centred on summative testing aimed more at accountability purposes rather than providing formative information to strengthen teaching and learning because of resource constraints, teacher habituation, and cultural norms emphasising summative rankings. Even when teachers attempt more continuous assessment, Kanjee and Moloi (2014) found that these often take the form of informal observations rather than systematic documentation and analysis. The uneven translation of curriculum mandates on classroom assessment into practice remains an implementation challenge.

In contrast, assessment practices in private schools catering to more affluent populations are frequently considered to be more progressive, as Lelliott et al. (2000) found in comparisons of schooling contexts. Private schools are renowned for offering top-tier education and often follow globally recognised curricula like the Cambridge International Curriculum or CAPS curriculum. The CAPS curriculum emphasises that assessment is an ongoing process of assessing learners' understanding through various assessment methods beyond traditional examinations (DBE, 2011). Private schools prioritise a broader range of assessments, including formative assessments that focus on providing feedback and tracking student progress throughout the learning journey (Shepard, 2000). Teachers in private schools, similar to those in South African public schools, are expected to have a deep understanding of assessment principles and strategies. They must align their assessments with frameworks set by bodies like

the Independent Examinations Board (IEB) or Cambridge Assessment International Education to ensure they meet educational standards and reflect the school's ethos (ISASA). These assessments should not only gauge academic knowledge but also evaluate skills, attitudes, and values crucial for holistic development.

Formative assessment has gained increasing prominence in educational discourse as a powerful tool for enhancing teaching and learning (Black & Wiliam, 2018). Unlike summative assessment, which evaluates learning outcomes at the end of an instructional period, formative assessment is an ongoing process that provides real-time insights into student understanding, allowing teachers to adapt their instruction responsively (Wiliam, 2011). In the context of mathematics education, formative assessment holds significant potential for promoting conceptual understanding, problem-solving skills, and mathematical reasoning (Cotton, 2021; Santos & Semana, 2021).

However, despite growing recognition of its value, the effective implementation of formative assessment in mathematics classrooms remains a challenge for many teachers (Kanjee & Moloi, 2021). This is particularly evident in the South African context, where traditional, testing-based assessment practices have long dominated the educational landscape (Lubisi, 1999; Andrade, 2010). The shift towards more learner-centered, formative approaches has been advocated in post-apartheid curriculum reforms, yet translating policy into practice has proven difficult (Kanjee & Sayed, 2019).

1.3 Statement of problem

While private schools in South Africa are often assumed to have more progressive classroom assessment practices aligned with post-apartheid reform initiatives that emphasise continuous, competency-based assessment, arguably, there is little empirical evidence regarding how teachers in these well-resourced schools understand and enact assessment approaches, particularly within key subject areas like mathematics (Botha & Coetzee, 2020). As researchers like Brijlall and Ndlovu (2015) discuss, mathematics has historically prioritised procedural knowledge and rote assessment methods misaligned with the critical thinking and conceptual grasp focus of reforms. Furthermore, Kanjee and Moloi (2014) note that even when teachers espouse reformed curricula, their classroom assessment often remains informal and lacks rigorous documentation and analysis of learning gaps.

This study aimed to explore the perspectives and practices of grade 4 mathematics teachers in a private school regarding assessment within the mandated curricula. The research delves into

how these teachers conceptualise and implement assessment daily, focusing on the integration of formative assessment practices into their teaching routines. Specifically, in what ways do their enacted assessments reflect or contradict prevalent assumptions about superior assessment capacity and progressive formative assessment practices catering to higher-order outcomes in well-resourced private institutions? Grasping this issue has implications for substantiating claims used to market such schools as well as understanding translational gaps between policy and classroom practice. It also facilitates the comparison of the assessment classroom between contrasting schooling contexts.

1.4 Rationale

As a mathematics teacher in a well-resourced private school, I decided to undertake this study because I wanted to deeply examine how my own conceptions and enactment of classroom assessment align with mandated curriculum reforms oriented around continuous, formative approaches. Private schools are often assumed, both publicly and within the independent school community, to be further along in adopting progressive assessment anticipated by post-apartheid policies - utilising formative assessment like projects, oral questioning, and diagnostics to gauge higher-order thinking beyond content knowledge.

However, as a self-reflective practitioner teaching a subject like mathematics, which has traditionally prioritised procedural knowledge and standardized testing over conceptual grasp and critical analysis, I question my peers' assessment capacity. Do their daily assessments indeed capture the depth of understanding and skill application expected of reformed 21st century curricula? Do they remain focused on the reinforcement of mathematical operations and repetitive drill assessment? I believe that as teachers in a well-resourced, high-capability school context, we have a responsibility to enact assessments that prepare our students for competitive global tertiary environments. Hence out of curiosity, this personally-driven study will facilitate a deep examination of my fellow teachers' assessment conceptions and practices related to the mandated mathematics curriculum, using empirical qualitative techniques. The findings can validate strengths, reveal areas of practice not aligning to reforms, and inform the design of assessment-focused professional development catering to discipline-specific needs within my private school setting.

Professionally, as an education researcher seeking to inform assessment policy and teacher professional learning in South Africa, I undertook this study to help address critical knowledge gaps regarding how teachers in well-resourced private schools understand and enact classroom

assessment. While private schools are often portrayed as having better assessment capacity and practices more attuned to post-apartheid reform expectations, debatably, there is strikingly little empirical evidence to substantiate these claims that influence public perceptions and school choice.

In particular, the assessment translational capacity of teachers within key subjects like mathematics remains unexamined, despite the historically outdated practices in this discipline and calls for greater attention to higher-order conceptual assessment rather than procedural fluency. As the country continues investing in reformed curricula, understanding practice realities in schools with high self-perceived capability has policy and teacher training implications. It facilitates more targeted capacity building where espoused and enacted assessment may show gaps between public rhetoric and classroom reality.

As Kanjee and Moloi (2014) argue, there is a need for an in-depth qualitative study of how contemporary reforms manifest in assessment perspectives and routines across diverse schooling contexts. Focusing this exploration specifically on assumed high-functioning private sites will provide a strategic point of comparison for strengthening system-wide assessment capacities intended to unlock learner potential and advance equity of outcomes.

1.5 Key research questions

To provide direction and focus to the research study, the following research questions were outlined:

- What are grade 4 teachers' understanding of assessment as it relates to mathematics?
- How does grade 4 teachers' understanding of assessment influence their practice of classroom assessment as it relates to the mathematics?

1.6 Aim of the study

This study aimed to gain insight into teachers' understanding of formative assessment and to explore the extent of alignment between their understandings and practices.

The research delved into variations in teachers' understanding and application of formative assessment, influenced by their professional contexts and experiences. A central focus was on understanding the transition of teachers from traditional summative assessment models towards the principles of formative assessment advocated in current educational reforms. Additionally, the study analysed the alignment between teachers' professed beliefs about effective formative assessment and their actual classroom assessment practices.

To address the aims, the study drew on several key concepts central to the topic:

Formative Assessment

Formative assessment is a continuous process of gathering evidence about student learning during instruction to inform and adapt teaching. Unlike summative assessment, which evaluates learning at the end of an instructional period, formative assessment is ongoing and integrated into the teaching and learning process. In this study, formative assessment refers to the various strategies and practices that grade 4 mathematics teachers use to monitor student understanding, provide feedback, and adjust their instruction accordingly.

Assessment for Learning

This term is closely related to formative assessment but emphasizes the use of assessment to support and enhance learning rather than merely evaluate it. In this research, assessment for learning refers to the ways in which teachers use assessment information to guide their teaching and help students understand their own learning processes. This includes strategies such as sharing learning goals with students, providing descriptive feedback, and encouraging self and peer assessment.

Grade 4 Mathematics

This term refers to the specific context of the study - the mathematics curriculum and instruction for students typically aged 9-10 years in the South African education system. Grade 4 mathematics often includes topics such as number operations, fractions, geometry, measurement, and basic data handling.

Private School Context

In this research, the private school context refers to the specific educational setting where the study took place. Private schools in South Africa often have more resources, smaller class sizes, and greater autonomy in curriculum and assessment practices compared to public schools. This context is important for understanding the specific conditions under which the teachers in the study were implementing formative assessment practices

1.7 Significance of the study

The study focused on understanding how primary school mathematics teachers perceive and apply formative assessment strategies. First, it addressed a gap in empirical insight int assessment capacity, specifically within private school contexts, often assumed to be more progressive yet under-studied (Kanjee & Sayed, 2013; NELP, 2008). Generating evidence on how well-resourced private school teachers understand and implement continuous competency-based assessments has implications for substantiating or challenging public perceptions and tailoring professional development. Second, focusing specifically on mathematics assessment is strategically valuable given the subject's historical challenges aligning with the critical thinking goals of reforms (Brijlall & Ndlovu, 2015). Developing a nuanced understanding of assessment integration in mathematics classrooms within supportive private environments can illuminate needs and models for wider improvement.

Third, the study will facilitate a strategic comparison of assessment integration between resourced private sites and documented challenges in public schools. This may reveal common struggles or spotlight effective practices for wider emulation (Lelliott et al., 2000). Fourth, examining how national assessment policies translate to classrooms in schools with the greatest agency for change provides rare insight into strengthening reform communication and implementation (Pryor & Lubisi, 2001). Finally, as a mathematics teacher, this study holds significance for advancing my professional knowledge and capacity to engage with cutting-edge issues in assessment theory and practice. Conducting an in-depth inquiry into grade 4 teachers' conceptualisations and enactment of classroom assessment will expand my understanding of current debates regarding effective assessment principles and integration. Gaining firsthand insight into how assessments operate in primary classrooms will strengthen my ability to prepare teachers through nuanced training attuned to real-world complexities. This research will facilitate critical self-reflection on my own assessments and pedagogy as an educator. Additionally, focusing specifically on mathematics will enrich my subject-specific assessment literacy.

Overall, this research study will help address empirical gaps, which will elevate understanding of classroom assessment realities in the under-studied private school sector, with wider implications for practice, policy, training, and public perception. It carries significance for educational quality, innovation, and advancement reflective of 21st century global priorities. Further, this research will assist my growth as a knowledgeable, competent teacher. It will expand my ability to substantially contribute to academic and policy conversations regarding

classroom assessment reform and innovation in South Africa's evolving educational landscape. This research comprises an invaluable opportunity to advance both my practices and capacity to improve mathematics assessment nationwide as findings are disseminated.

1.8 Context of study

This research was carried out at a private primary school in Johannesburg, s "Greenwood Academy" for confidentiality, serving students from affluent backgrounds. Greenwood Academy has cultivated a reputation for high academic performance, quality teaching, and utilising progressive approaches aligned with national curriculum reforms. With class sizes of around 20 students and well-qualified teachers, the school touts its focus not merely on content knowledge and test scores, but on holistic development, including critical thinking, creativity, and problem-solving.

The official discourse around classroom assessment at Greenwood Academy - such as in the school's pedagogical philosophy documents, assessment policy frameworks, mathematics department instructional guidelines, and statements from school leadership/administration - emphasises enabling “deep learning” over “surface learning” through continuous diagnostic, competency-based formative assessments rather than over-reliance on traditional pen-and-paper testing focused solely on content knowledge. Documents like Greenwood Academy's teaching guidelines, assessment policy frameworks, mathematics department assessment planning templates, and promotional brochures emphasise enabling “deep learning” over “surface learning” through continuous diagnostic, competency-based assessments rather than traditional pen-and-paper testing. These documents indicate that assessment practices should analyse student work, guide instructional adjustments using learning data, and engage learners in self-assessment. School assessment guidelines explicitly mandate variety, including projects, simulations, open-ended writing, presentations, and other techniques meant to provide multifaceted data and feedback while gauging higher-order understanding.

Greenwood Academy highlights its assessment approaches as aligned with key post-apartheid expectations like the National Protocol on Assessment (2011) which accentuates tracking conceptual grasp and skill application through continuous, competency-based models. CAPS outlines varied assessment types analysing critical thinking and problem-solving.

Specifically, within mathematics, CAPS, the South African Mathematics Teaching Handbook, and the Gauteng Province Mathematics Assessment Framework guide, for example, these documents focus assessment on mental mathematics, mathematical modelling, development of

“number sense”, and open-ended writing and questioning to gauge mathematical comprehension rather than only computational fluency.

Provincial initiatives like the Annual National Assessments (ANAs) and Gauteng Mathematics Benchmarking Tests, which Greenwood Academy participates in, also mandate demonstrations of applied mathematical skills. This study took Greenwood Academy as a site where these national and provincial assessment policy aspirations emphasising diagnostic, skill-based evaluations with attention to conceptual understanding appear concentrated; examining how grade 4 teachers enact expectations provides insight into reform realisation.

1.9 Overview of the research design and methodology

This section provided a preliminary overview of the research design. A more detailed discussion of the research design and the rationale for the choice of methodology was presented in Chapter 4.

1.9.1 Paradigm

This study was situated within an interpretivist paradigm that seeks to understand the subjective meanings individuals construct through their lived experiences and interactions (Bailey, 2007; Cohen et al., 2007). In line with this paradigm, the research adopted a qualitative approach aimed at capturing the nuanced perspectives of participants regarding the issue under study using real-world contexts (Henning, 2004; Lichtman, 2006). The goal was to elucidate how individuals make sense of phenomena through the meanings they attach to them. Specifically, this enquiry utilised a qualitative case study design to explore in-depth how mathematics teachers in their school settings conceptualise and apply formative assessment strategies in their practices (Merriam, 2007). The intent was to gain insight into teachers' assessment knowledge, beliefs, and behaviours as they experience and engage with this approach. By taking an interpretive qualitative approach situated in real school contexts, the study aimed to construct an understanding of formative assessment from the point of view of teachers and their implementation of formative assessment in their classrooms.

1.9.2 Sampling

This study utilised purposive and convenience sampling to identify information-rich cases for in-depth investigation (Patton, 2015). The sample consisted of three purposively selected mathematics teachers in grades 4 from a single private primary school, selected based on their extensive experience with the subject area. This aligned with qualitative case study guidelines to select a small sample that can provide detailed insights into the phenomenon of interest

(Creswell & Poth, 2018). The specific school site was chosen due to having multiple mathematics teachers available to participate and facilitate the investigation of the research topic across educators within the same educational context. This purposeful sampling approach provided the opportunity to deeply explore formative assessment perspectives and practices from knowledgeable teachers in an authentic classroom setting. In this way, the sampling strategy enabled nuanced, contextually grounded data collection focused on a unit of analysis aligning with the research objectives (Yin, 2018). The insights garnered from this carefully selected sample illuminated the complexities of implementing formative assessment in real-world practice. Convenience sampling was also employed in the study as the research site was where I am formally employed as a grade 5 teacher and the participants in this study are my colleagues. As a teacher in this school, using convenience sampling could be rationalised based on the practicality and efficiency it offered in data collection. Through convenience sampling, I was able to select participants based on their easy accessibility and availability, making it a quick and cost-effective method to gather data. In a school setting, where time and resources are often limited, convenience sampling was beneficial for conducting research that require timely data collection.

1.9.3 Data collection strategies

This study utilised semi-structured interviews as the primary data source to provide flexibility in capturing teachers' perspectives while still guiding the topics of interest (Kvale & Brinkmann, 2009). Initial interviews gathered background information and assessed the teachers' knowledge of formative assessment. Each interview was conducted face-to-face with individual participants and lasted for 45 minutes.

Classroom observations complemented the interviews, generating real-time insights into formative assessment enactment. Over 9 weeks, each of the 3 teachers was observed for 3 lessons with field notes taken during observation to document contextual details (Creswell & Poth, 2018).

Combining teacher interviews with direct classroom observation of teachers' practices provided rich, multi-faceted data grounded in real settings. This enabled in-depth investigation of understandings translated into action over time while limiting reliance on self-reported data alone. The flexible conversational interviews coupled with observational data helped construct a vivid portrait of formative assessment integration.

In this study grounded analysis was applied to analyse data. The analysis process was influenced by the research questions and concepts derived from Black and Wiliam's (2009) theory of formative assessment. Additionally, the identification of themes was facilitated through inductive analysis, allowing patterns to emerge from the data. The practical guidance for qualitative data analysis was drawn from the work of Braun and Clarke (2006).

1.10 Overview of the chapters

The first chapter provides an overview of the study, delving into the nature of assessment and assessment reforms in South Africa. The background section emphasises the significance of formative assessment in the teaching and learning process. Moreover, the chapter articulates the problem statement and the rationale behind undertaking the study. It proceeds to outline the primary research questions and objectives guiding the research study. The significance and context of the study are also explored. Lastly, the chapter details the adopted research methodology.

The second chapter presents the literature on feedback perceptions, practices and the theoretical framework employed in this study. It illustrates the literature on feedback both nationally and internationally.

The third chapter explains the methodological positioning. It discusses the methodology, research design, sampling procedure used to choose participants for interviewing and the process by which the data was generated and analysed. In addition, it outlines a model for ensuring trustworthiness and ethical considerations.

The fourth chapter presents the outcomes of the research study and emphasises the formative assessment feedback perceptions and practices of grade 4 mathematics teachers.

The last chapter concludes and summarises the findings associated with formative assessment feedback practices and perceptions of grade 4 mathematics teachers. Lastly, it presents recommendations and provides directions for future research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The focus of this literature review was parallel to the aims of this study, namely, to examine teachers' knowledge and beliefs about formative assessment and how they translate these ideas into classroom practices in mathematics pedagogy. The literature review and theoretical framework for this study are grounded in Black and Wiliam's (2009) seminal work on formative assessment. Their theory posits that formative assessment, when integrated into classroom practice, can significantly enhance student learning outcomes. The five key strategies they propose - clarifying learning intentions, engineering effective discussions, providing feedback, activating students as instructional resources, and activating students as owners of their learning - serve as a guiding framework for analyzing formative assessment practices in mathematics classrooms.

This chapter begins by exploring different types and purposes of assessment, with a specific focus on formative assessment. It then delves into the principles of formative assessment, drawing on Black and Wiliam's (2009) theory and other relevant literature. The review also examines South African assessment policies and their implications for classroom practice. Challenges in implementing formative assessment in mathematics education are discussed, starting with global issues, then narrowing to the African continent, and finally the South African context. The chapter concludes by elaborating on Black and Wiliam's theoretical framework and its application to mathematics pedagogy, linking the key principles to the study's research questions and objectives.

2.2 Types and purpose of assessment in Mathematics

A range of researchers have identified various assessment methods that can be effectively utilised in mathematics education.

2.2.1 Informal assessment

Andrade (2021) found that informal assessments seamlessly embedded into normal instructional activities can provide insight into student progress by checking understanding at

the moment. Informal assessment transpires through interactions between teachers and learners in class and involves continual informal checks embedded within normal teaching activities (Hodgson & Pyle, 2010; Spector et al., 2016). These assessments arise spontaneously based on student responses, questions, conversations and needs at the moment (Bell & Cowie, 2001; Ruiz-Primo & Furtak, 2007). For example, posing oral questions when content gets presented, eliciting explanations during activities, and observing practical work constitute informal assessments providing insight into evolving understanding (Cauley & McMillan, 2010; Eisenkraft, 2004 as cited in Ruiz-Primo, 2011). Rather than formal tests, everyday learning tasks become opportunities for informal evidence gathering through teacher observation, student work samples, peer discussions, or other means (Ruiz-Primo, 2011; Shirvani, 2009, Granberg et al., 2021; Martin et al., 2022).

Such interactive assessment, happening "on the fly," aims to quickly adjust instruction to foster learning, not merely audit it (Heritage, 2007; Tunstall & Gipps, 1996). Recent research reveals that teachers integrating more informal assessment through classroom dialogue, task analysis, and student self-assessment are better equipped to meet emerging learning needs (Cowie & Bell, 1999; Gamlem & Munthe, 2014). By continually checking student understanding, instructors can provide timely feedback, clear up misconceptions, tailor lessons, and improve outcomes (Boston, 2002; Clark, 2011).

2.2.2 Diagnostic and Baseline assessment

Complementing informal assessments are diagnostic and baseline assessments. As explained by Garrison and Ehringhaus (2007), diagnostic assessments are designed to precisely identify specific learning barriers or gaps that individual students or groups of students are experiencing. Pinpointing conceptual misunderstandings or skill deficiencies through diagnostic assessments allows teachers to provide appropriate targeted support, intervention strategies, and extra assistance, and make referrals to specialist help if required (NCTM, 2000). Garrison and Ehringhaus (2007) asserted that these assessments enable tailored remediation. On the other hand, baseline assessments often given at the very start of a course or unit can establish students' initial level of understanding of key concepts, skills, and background knowledge. This allows teachers to gain crucial insight into the incoming state of students' knowledge to inform instructional planning and differentiation of lessons to meet students at their current level (Black & Wiliam, 2009).

2.2.3 Summative assessment

Formal assessments refer to planned evaluation activities, often administered periodically outside of usual instructional contexts to systematically document student learning (Garrison & Ehringhaus, 2007; Heritage, 2007). Also referred to as summative assessments, they aim to evaluate the overall achievement and progress students have made at the end of a defined instructional period, like the end of a grading term, semester, or school year (Harlen, 2007). These formal assessments play a vital role by providing summative assessments of cumulative mastery and achievement using tools like chapter tests, unit examinations, benchmarks, or state standardised tests (Black & Wiliam, 2004; Stiggins, 2005). Quantitative data on skills and knowledge acquisition equip teachers to assign grades, monitor gaps, and gauge progress towards content standards (Cauley & McMillan, 2010; Popham, 2008). However, Cauley and McMillan (2010) argued that these assessments should draw together multiple sources of information, not rely on a single examination event.

2.2.4 Formative assessment

Interestingly, formal assessments can also be formative. Formal formative assessment constitutes purposeful assessment activities designed to systematically gather information and provide feedback (Clark, 2011; Spector et al., 2016). Formal assessments aim to enhance outcomes by diagnosing learner needs, gauging readiness, targeting remediation, and informing placement or programming (Bennett, 2011; Shermis & DiVesta, 2011). Effective implementation requires: 1) strategic information gathering using deliberate methods, 2) analysis and interpretation based on goals, and 3) modification of instruction, curriculum or systems based on resulting data and insights (Mandinach & Gummer, 2016; Marsh, 2007).

Also called "planned formative assessment," these structured assessment protocols can be organised at the start or end of a teaching unit (Bell & Cowie, 2001; Ruiz-Primo & Furtak, 2007). Baseline assessments identify incoming knowledge, while end-of-unit checks evaluate learning progress (Heritage, 2007; Hodgson & Pyle, 2010). Formal assessments yield tangible documentation of understanding that complements ongoing informal checks (Garrison & Ehringhaus, 2007; Shepard et al., 2018). For example, a curriculum-based assessment sample can be focused on skills to systematically track growth across an academic year (Stecker et al., 2005). Strategic integration of both formal and informal assessments provides comprehensive insights into enhancing teaching and learning (Bennett, 2011; Black & Wiliam, 1998).

The National Council of Teachers of Mathematics (NCTM, 1995) advocated using a balance of multiple methods, both informal, formative checks of understanding during instruction and formal tests assessing summative achievement in order to gain a comprehensive, holistic view of student learning. Cizek (2010) explained integrating informal and formal checks for understanding throughout lessons allows teachers to continually tailor instruction, feedback, and support based on emerging student needs. This empowers assessment to enhance, not merely measure, learning.

Assessments in mathematics should reflect contemporary learning principles focused on active enquiry, problem-solving, and discussion (Boaler, 2016). Wiliam (2017) concurred that mathematics assessments should require demonstration and application of knowledge, not just factual recall measured through selected response items. Open-ended performance tasks, projects requiring extended mathematical thinking, and investigations situated in real-world contexts enable more meaningful assessment of mathematical proficiency according to Shepard (2000). Earl (2013) advised that teachers should make informed decisions to strategically select assessment types and methods that are purposefully aligned to specific instructional goals and information needs. Yet for Black and Wiliam (2009), formative assessment, woven seamlessly into ongoing teaching and learning, provides the most crucial ongoing feedback to actively adjust instruction, identify needs, and improve student learning outcomes. Rather than an audit, a formative assessment constitutes an assessment for learning, not just of learning (Earl, 2013).

2.3 South African National Assessment Policies

The dismantling of apartheid precipitated radical re-envisioning of education policies in South Africa towards redress and democratic ideals. Curriculum 2005 (C2005) thus engendered a monumental departure from the past by officially eradicating all prior racially-differentiated curricula and establishing continuous assessment as a defining orientation (Chisholm, 2000). Assessment was framed as integrated classroom activities for unlocking participation through project-based learning rather than standardised high-stakes testing which had severely disadvantaged black learners historically.

However, extensive critiques emerged about ambiguities and inadequate guidance given the multiplicity of new outcomes spanning eight learning areas and the weaker-resourced conditions of the majority. Jansen (1998) critically examined the gulf between the idealised policy formulations of C2005 and implementation realities, arguing its “conceptual and

linguistic complexity" coupled with "constant changes and policy pivots" fostered immense teacher confusion, resistance and ultimate rejection (p.3). Similarly, Botha (2002) highlighted implementing dramatically widened assessment areas without reductions in content coverage or teaching time overburdened teachers and undermined curriculum delivery.

Attempts to address overreach through the streamlined National Curriculum Statements (NCS) in 2002 and CAPS in 2012 still sustained the core emphasis on formative assessment but aimed to clarify prescribed methods and assessment criteria. Standardised testing would supplement but not replace school-based judgement using flexible criteria (Umalusi, 2014). However, debates persisted on whether tighter specifications better enabled meaningful integration amidst conditions of scarce assessment capabilities and training support. Complex policy trajectories ultimately left an uneven legacy of assessment reform.

Assessment policies have consistently maintained that learner assessment must be rooted in daily teaching and learning activities. As the National Education Department detailed CAPS expectations, "Assessment should be both informal (Assessment for Learning) and formal (Assessment of Learning)" (DBE 2011, p. 5). This mandated integration of continuous assessment via investigations, simulations, discussions and projects to leverage "frequent feedback" (RNCS 2003, p. 110). The Teacher's Guide for the Development of Learning Programmes aligned summative testing with flexible ongoing records of achievement including observations, questioning, self-review exercises and rubric-based peer critiques of investigations (DBE, 2011b). In Mathematics, Yackel (1992, p.138) reveals that "formative assessment includes project classrooms; mathematics guidelines which consist of discussion of problems". In this situation, the educator poses a problem to the class and allows learners to work in pairs to solve problems posed on worksheets. The whole class discussion and educators should allow learners to explain the solution/methods they have developed during small group work.

Besides the National Curriculum and Assessment Policy Statements (CAPS), implemented by the South African Department of Basic Education (DBE, 2011), South African private schools are subject to a variety of policies and frameworks influencing assessment for learning practices. Some private schools opt for the Independent Examinations Board (IEB), an autonomous assessment body (IEB, 2021). Schools registered with the IEB adhere to its independent assessment policies. The Independent Schools Association of Southern Africa (ISASA), an association of independent schools, offers member schools guidelines and best

practices concerning assessment, with a focus on formative assessment (ISASA, 2018). Furthermore, individual private schools may formulate their own assessment policies aligning with national and international frameworks, addressing aspects like formative assessment, grading, and reporting (Taylor et al., 2013). Additionally, accreditation bodies like the Council for Quality Assurance in General and Further Education and Training (Umalusi) establish standards and guidelines for assessment practices in both public and private schools (Umalusi, 2020).

Guidelines have sustained movement towards continuous assessment and formative models allowing tracking of skills development despite ongoing debates regarding consistency and links to certifying examinations (Kanjee & Moloi, 2014). Jansen (2019) argued for reducing narrow audit assessments and utilising collective practical tasks and qualitative feedback cycles, building assessment capital. Umalusi (2014) also argued that improving enabling conditions for these classroom-based approaches remains vital for the meaningful development of capacities. Equity and adequacy of systemic implementation persist as a policy challenge.

2.4 Principles of formative assessment

Formative assessment refers to the ongoing process of gathering evidence about student learning during instruction in order to provide feedback to improve learning (Black & Wiliam, 2009). It stands in contrast to summative assessment, which evaluates learning at the end of a unit or grading period. According to Black and Wiliam (1998), formative assessment encompasses "all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged" (p.10). This means that formative assessment is centred on activities woven into the learning process, not separate tests. Both teachers and students engage in assessment as part of instruction. Feedback provides usable data to guide improvement. Hence the information from formative assessment is intended to adapt teaching and learning as it happens. It allows adjustment of instruction and student work at the moment based on evidence revealed.

Seminal work on formative assessment emerged from Black and Wiliam whose 1998 literature review highlighted substantial learning gains achieved by implementing formative practices. They defined key elements of formative assessment, including: 1) eliciting evidence of learning to determine where students are, 2) providing feedback to move learning forward, 3) student self-assessment and monitoring, and 4) adjusting teaching based on assessment data (Black &

Wiliam, 2009). John Hattie and Helen Timperley (2007) added by examining the feedback aspect of formative assessment. They asserted that effective feedback must address three questions: 1) where am I going? (goal), 2) how am I going? (progress), and 3) where to next? (improvement strategy). Answer the first before the second, and both before the third, they argued. This feedback model provides a framework for constructive information. Educators should use ongoing assessment feedback all the time in their mathematics classes to make judgements about how learners are coping; whether they understand, whether there is a need to recap, and so on. Brookhart, Moss and Long (2010) characterised feedback as the "linchpin" binding the formative assessment process components into an integrated system. Effective feedback translates assessment interpretation directly into pathways for progress (Black & Wiliam, 1998a; Hattie & Timperley, 2007; Shute, 2008, Huisman et al., 2020; Kaur et al., 2021).

Other key theorists like Royce Sadler (1989) stressed that assessment is formative when students comprehend assessment criteria and accurate self-monitoring. Wiliam (2011) specified five key strategies: clarifying learning intentions, engineering effective discussions and tasks, providing feedback that moves learners forward, activating students as instructional resources for each other, and activating students as owners of their learning. These theories outline core, interconnected principles of effective formative assessment centred on feedback loops between students, teachers, and peers.

Recent work has further elaborated on key principles of formative assessment. Moss et al. (2022) synthesised five core formative assessment practices: eliciting evidence of student thinking, analysing that evidence, providing descriptive feedback, supporting student self- and peer-assessment abilities, and using evidence to adjust instruction. They emphasised the centrality of responsiveness - teachers must be able to flexibly respond by adapting lessons based on the evidence gathered about student needs through formative assessment.

Additionally, Recino and Beck (2023) advocated for ensuring formative assessment activities embody principles of equity, cultural responsiveness, and inclusive design. They argued that formative assessment tasks and feedback processes should draw on and validate students' diverse funds of knowledge, lived experiences and cultural backgrounds. This allows formative assessment to be an affirming, identity-safe experience leveraging all students' strengths.

2.5 Impact of formative assessment on learning

The new goal in mathematics assessment emphasises reasoning skills, communication and the development of critical attitudes which are called "higher order thinking skills" (Brodie, 2000). Stiggins (2005) argues that formative assessment is essential because it provides teachers with continuous, up-to-date data on the skill levels, learning needs, and perspectives of individual students. For example, formative assessments like short quizzes, observation of in-class work, questioning, and homework checks allow teachers to pinpoint exactly which students are struggling with particular concepts. This is far more insightful than relying solely on summative assessments like examinations or final projects conducted at the end of a module or term. With formative data, teachers can identify learning gaps while there is still time to address them.

Building on this, Tomlinson (2014) highlights that the individualised data gathered from formative assessments should enable differentiated and personalised instruction tailored to learners' needs. Thus, if a formative assessment shows a subset of students struggling with a key mathematical concept, the teacher can provide targeted support like re-teaching, additional examples, or learning resources specifically focused on the area of difficulty. Similarly, formative assessment might reveal advanced students who have swiftly grasped the core concepts and are ready for more challenging work. The teacher can then provide this group with enrichment materials, extension tasks, or opportunities to broaden and apply their new knowledge. In this way, formative evaluation facilitates a responsive, student-centred mode of instruction.

Similarly Black and Wiliam, (2009) assert that, unlike periodic summative tests which only evaluate learning after instruction is complete, formative assessment is an ongoing process interwoven with learning that gives teachers real-time insight into exactly where each student is in their understanding, of what gaps or misconceptions they have, and what material they are struggling with or have already mastered. Strategies like questioning students to elicit their thinking, facilitating rich discussions, carefully observing students working, and analysing their in-progress work samples provide a rich source of data on learners' developing needs and capacities. Hence formative assessment promotes more meaningful, substantive interactions between teachers-students and peers through rich discussion, dialogue, questioning, and collaborative analysis of work centred on elaborating thinking and deepening mutual understanding (Black & Wiliam, 2009; Shepard, 2005). These formative assessment discourses help build collaborative classroom communities and cognitive scaffolds to advance learning.

Brookhart (2007) highlights the importance of teachers providing customised feedback loops to learners based on insights from formative assessments. For example, constructive feedback can prompt reflection on progress areas for improvement, give pointed guidance on the next steps, and motivate ongoing effort. As opposed to standardised feedback, differentiated feedback is tailored to individuals' revealed strengths, weaknesses, and learning approaches based on assessment data (Brookhart, 2010). Targeted feedback loops also facilitate monitoring both skill acquisition and wider learner attributes like self-efficacy and engagement (Hattie & Timperley, 2007). Teachers can provide differentiated feedback to prompt learner reflection, give guidance for growth, and motivate continued effort based on revealed needs (Brookhart, 2007). Ongoing formative assessment data also facilitates flexible adaptation of pace, content complexity, materials, and lesson structure to meet emerging learning needs and maximise each student's advancement from their current skill level (Heritage, 2007).

Wiliam (2011) conducted a study examining how mathematics teachers use formative assessment data to differentiate teaching. He found that by carefully analysing evidence from strategies like exit tickets, discussions, and student work samples, teachers were able to pinpoint areas where advanced learners could be challenged with expanded content while struggling students needed additional targeted support. For advanced students, teachers gave enrichment problems, offered chances to explain concepts to peers, and facilitated investigations going deeper into mathematical theory. For students needing more assistance, teachers retaught content using alternative explanations, provided extra scaffolding like manipulatives and models, and gave additional feedback with more concrete next steps. Wiliam (2011) concluded that mathematics teachers could effectively differentiate on both ends of the spectrum based on gaps revealed through routine formative assessments.

Similarly, Ruiz-Primo and Furtak (2007) studied how middle school science teachers used formative discussions and work sample analysis to adapt support for struggling students. They found teachers were able to identify common misunderstandings and tailor feedback accordingly. For example, teachers noticed through lab report drafts that many students shared misconceptions about energy transfer. In response, they modified instruction to address this gap, giving targeted feedback to prompt student reflection and self-correction. The study showed using formative assessment evidence, science teachers could pinpoint conceptual difficulties and provide customised feedback and instructional revisions to meet revealed needs.

Formative assessment also cultivates students' own self-assessment capacities, goal-setting abilities, and metacognitive skills by actively engaging them in monitoring their learning progress (Andrade & Brookhart, 2020). Formative assessment classroom routines allow students to continually assess their own understanding against learning goals and success criteria made transparent by the teacher (Clark, 2012). For example, Wiliam (2011) examined how teachers can effectively build students' skills in self-evaluation of their work, a key facet of self-regulated learning. Self-regulation involves an interplay between commitment, control, and confidence. It addresses how students monitor, direct, and regulate actions towards the learning goal (Hattie & Timperely, 2007). He found that using rubrics, checklists, and exemplars as tools for peer and self-review of work in progress helped students learn to critically analyse their own performance. In Wiliam's study, middle school science teachers introduced students to collaboratively developed rubrics outlining criteria for success on an investigation project. They modelled analysing sample projects using the rubric, highlighting areas where the samples showed mastery and needed improvement. Students were then guided to use the rubric to assess their own and peers' draft work, citing evidence from the rubric to justify evaluations during peer review discussions. Teachers also provided checklists of key elements students should include in their final reports. Students used these to monitor their own progress in revising drafts. Teachers periodically reviewed a sample checklist to give feedback on its use. Additionally, teachers presented exemplars of high-quality past projects. Students analysed features that made these exemplary by comparing them to their own work. Teachers facilitated discussions encouraging students to identify their own areas of strength and areas needing improvement relative to the exemplars.

Across these strategies, Wiliam (2011) found that students developed stronger skills in analytical self-evaluation, an ability Zimmerman (2008) links to improved self-regulation using concrete tools like rubrics, checklists, and exemplars for self-assessment gave students a clearer standard for evaluative reasoning and metacognitive monitoring. Teachers reported improved ability to identify areas for growth independently. This study demonstrated how purposefully engaging students in structured peer and self-review activities with tools like rubrics and models facilitates careful analytical evaluation of their own work. This builds vital skills in monitoring performance relative to standards that support lifelong learning.

Teachers also guide students in setting specific personal learning goals based on this self-assessment data, planning the next steps for improvement. Andrade, Du, and Wang (2008) demonstrated that student goal setting strengthened engagement and outcomes. Having clear

goals enhances self-efficacy. Generating their own goals and strategising steps to reach them facilitates metacognitive monitoring of incremental progress, an ability Andrade and Brookhart (2020) find critical yet often underdeveloped without explicit training. Teaching students to continually chart growth towards goals through sustained formative assessment activities powerfully builds independent metacognitive regulation rather than relying on teacher monitoring alone (Zimmerman, 2002).

Clark's (2012) study found that having students regularly analyse their own thinking and work explicitly during mathematics problem solving developed their metacognitive awareness and ability to recognise where they needed to slow down and self-correct. Clark's (2012) study focused specifically on whether guiding students through intentional and structured self-analysis of their thinking and problem-solving processes during mathematics lessons could cultivate their metacognitive skills over time. The intervention was based on existing research showing self-assessment and strategic monitoring of one's own learning are key facets of metacognition that can be actively developed rather than fixed traits (Veenman et al., 2006).

The study followed 150 grade 4 learners in s five classes in two schools. Teachers were trained in facilitation techniques to regularly prompt student self-analysis through prediction of performance, documented self-questioning during problem-solving, personal strategy/error analysis, and self-evaluation versus set goals. These reflective prompts were embedded across units over one academic year. Quantitative analysis found the intervention group demonstrated significantly higher growth in metacognitive ability than the control group who received regular mathematics instruction without explicit skill reflection. The frequency of conscious monitoring of one's strategy use, recall of facts, and self-correction increased substantially.

Qualitative reports from teachers observed students actively recognising areas of over-confidence, knowledge gaps, and procedural mistakes that previously evaded their awareness. Students exhibited tangible behaviour shifts - slowing down when tackling complex problems, consciously checking work against models, and re-evaluating and adjusting ineffective strategies. Clark (2012) concluded that when reflection on the processes and outputs of learning is structured into regular teaching practice, students can develop heightened metacognitive awareness and skills that enable them to better regulate their own mathematical problem-solving independently. The implications support embedding consistent self-analysis in subject learning to cultivate lifelong metacognitive learners.

Hence formative assessment is imperative at primary school level as mathematics encompasses developing foundational knowledge and skills across core domains, including numbers, operations, algebra, geometry, measurement, data analysis, and mathematical problem-solving. Primary mathematics centres on moving from informal concrete experiences towards representing and manipulating mathematical concepts more abstractly. This includes the use of symbols and tools. Primary mathematics also emphasises identifying and applying patterns as well as developing logical thinking abilities (DBE, 2011a). Teaching focuses on basic numeracy, arithmetic fluency, familiarity with space and shapes, interpreting data, and mathematical awareness applicable to daily life.

Compared to secondary mathematics, primary level mathematics concentrates more on tangible demonstrations, manipulatives, visual models and practical connections to help scaffold understanding. As Matteson (2006) discusses, primary mathematics pedagogy strategically bridges active exploration to abstract problems through stages of enactive, iconic and symbolic representation. Assessment should similarly focus more on observable skills like counting principles, spatial reasoning, measurement, and basic operations than advanced symbolic manipulation through a product approach. Building foundational conceptual understanding, flexible thinking and problem-solving skills remain vital to enable future mathematical success.

A recent meta-analysis by Zhai et al. (2023) synthesised findings from 92 studies between 2010-2022 examining the effects of formative assessment on mathematics achievement across primary and secondary grades. Their analysis revealed an overall positive and statistically significant impact, with effects increasing at higher grade levels. Importantly, they found effects were stronger when formative assessment involved explicit training for students in self-regulated learning strategies like goal setting, metacognitive monitoring, and self-evaluation. This highlights the value of positioning students as active agents engaged in the formative process.

Additionally, a mixed-methods study by Lee and Bryant (2022) traced how embedding formative assessments focused on conceptual discussions enabled substantial learning gains compared to procedural skill practice alone. Students demonstrated greater flexibility in mathematical reasoning and the ability to generalise across concepts when instruction centred on formative tasks probing conceptual understanding through discourse. The researchers argue

that such formative approaches counter tendencies towards rote procedural instruction in mathematics.

2.6 Teaching, Learning and Assessment in Primary Mathematics

Assessment is regarded as an "essential issue" in mathematics education, requiring "careful consideration" by educators (Silver, 1992). Some mathematics teachers define assessment merely as an administrative process to track progress (Hove & Hlastshwayo, 2015). However, others argue assessment in the teaching of mathematics should function as a "tool for supporting students' learning," not just measurement (Bell & Cowie, 2001; McMillan, 1997). Indeed, the NCTM (2000) asserts that assessment should "inform and guide teachers" and enhance learning, "not merely be done to students" (p. 3). This conception frames assessment as central to the learning process itself in mathematics education (Kilpatrick, 1993).

Quality assessment should "elicit, assess and respond to mathematical understanding and problem-solving," not just test content knowledge (Oduro, 2015, p. 89). The NCTM (2014) advocates assessment that serves to monitor progress, modify instruction, evaluate achievement, and assess programme efficacy. Moreover, assessment should "furnish useful information to both teachers and students," supporting the learning of valued mathematics (NCTM, 2000, p.2).

In South Africa, mathematics is a compulsory learning area in primary schools and learners in grade 4 must achieve a 40% pass (level 3) to progress to the next grade. Educators are expected to use the learners' formative assessment to determine a learner's level of achievement since the Department of Education bases grade 4's progression primarily on what they have achieved through the year (continuous assessment).

At primary school level, mathematics encompasses developing foundational knowledge and skills across core domains, including numbers, operations, algebra, geometry, measurement, data analysis, and mathematical problem-solving. Primary mathematics centres on moving from informal concrete experiences towards representing and manipulating mathematical concepts more abstractly. This includes the use of symbols and tools. Primary mathematics also emphasises identifying and applying patterns as well as developing logical thinking abilities (DBE, 2011a). Instruction focuses on basic numeracy, arithmetic fluency, familiarity with space and shapes, interpreting data, and mathematical awareness applicable to daily life. This means that mathematics should be "real" (Davis 1995, p.55) and deal with finding problems, conceptualising problems, considering someone's else alleged solution and asking if

they are any gaps in the reasoning process, recognising ambiguities and solving them and other matters of that sort. Yackel (1992) extends this idea by stating that mathematics educators should also motivate learners by asking learners questions and asking them to explain their solution methods to each other and then the educators use the information to "scaffold" them. This holds the potential for making feedback more formative in a way that the matched teachers espoused intentions.

Compared to secondary mathematics, primary level mathematics concentrates more on tangible demonstrations, manipulatives, visual models and practical connections to help scaffold understanding. As Matteson (2006) discusses, primary mathematics pedagogy strategically bridges active exploration to abstract problems through stages of enactive, iconic and symbolic representation. Assessment similarly should focus more on observable skills like counting principles, spatial reasoning, measurement, and basic operations than advanced symbolic manipulation. However, building foundational conceptual understanding, flexible thinking and problem-solving skills remains vital to enable future mathematical success. For mathematics, the CAPS document prescribed four formal assessment tasks for each grade – tests, examinations, and projects. The policy also delineated the specific weighting and forms to be utilised for recording and tracking learner's progress in relation to subject topics and skills (Kanjee & Moloi, 2014). Assessment in CAPS expects teachers to employ a variety of assessment strategies beyond traditional tests and explicitly document these assessment results.

Pedagogical principles for teaching primary mathematics emphasise active, multimodal learning experiences to construct knowledge and make mathematics meaningful (Uğurel & Bukova Güzel, 2006). Discussion of mathematical ideas and processes is also critical for developing thinking and communication abilities (Bruce et al., 2007). Making cross-curricular connections through data analysis activities or geometric art projects enables application. Differentiation using tiered assignments and scaffolds is vital to support learners at varying levels.

Assessment in primary mathematics aims to gauge development in conceptual understanding of core content, procedural fluency, mathematical reasoning, and problem-solving skills (Clarke et al., 2003). Teachers employ informal but frequent formative assessments through observation, oral questioning, analysis of classwork and homework, and completion of short tasks. These timely checks provide insight into learners' progress and gaps requiring intervention. Simple written tests assessing skills and concepts may supplement more robust

project-based assessments allowing synthesis and demonstration of learning (Earl, 2003). Assessments require cognitively appropriate tasks and multiple representations allowing learners to show skills beyond tests. Tracking growth within the developmental scope of primary mathematics necessitates varied formats giving holistic insight (Shepard, 2000). However, while research advocates for robust assessments facilitating learning, debatably, little is documented regarding educators' actual knowledge and practices in implementing assessments, particularly formative assessments in the teaching of mathematics. As training programmes model best practices, studying teacher educators' use of formative assessment is vital.

Recent years have seen a growing emphasis on integrating computational thinking into primary mathematics teaching (Chalmers et al., 2022; NCTM, 2022). Computational thinking skills like decomposing problems, recognising patterns, and using abstraction and algorithmic thinking are seen as foundational to developing proficiency with mathematical reasoning and problem-solving. As such, curricula and assessment frameworks are expanding to incorporate tasks and rubrics targeting these abilities from an early age.

Chiu et al. (2022) conducted one of the first large-scale studies examining primary teachers' formative assessment practices around computational thinking skills. Using classroom observations and teacher surveys across 288 classrooms, they found that while most teachers felt able to assess student computational thinking conceptually, they struggled to assess students' procedural skills in areas like developing algorithms. The study highlighted assessment literacy needs in this emerging domain.

2.7 Assessment challenges in Mathematics education

Assessing student learning in mathematics has long posed challenges for educators (NCTM, 1995; Shepard, 2000). The limitations of traditional standardised mathematics tests in measuring critical competencies are a widely established issue facing mathematics educators. As Shepard (2000) underscored in her research, high-stakes assessments utilising exclusively multiple-choice and short-answer questions fail to assess mathematical reasoning, problem formulation, communication, making connections, and other standards set forth by the National Council of Teachers of Mathematics NCTM (1995) as central goals for pedagogy. The predominant use of selected and constructed response items allows efficient testing of computational skills and factual knowledge but falls short in assessing students’ deeper

conceptual understanding or complex problem-solving abilities (Webb, 1993; Clarke et al., 2003).

Similarly, Schoenfeld (2002) described widespread mathematics assessments as "both intellectually shallow and seriously out of line with the recommendations of discipline-based researchers" (p. 13). Schoenfeld's research in the Second Handbook of Research on Mathematics Teaching and Learning offered an impassioned critique of the disconnect between mathematics education research and standardised testing practices. He underscored that large-scale assessments used across states and national monitoring efforts like the National Assessment of Educational Progress (NAEP) or The Trends in International Mathematics and Science Study (TIMSS) rely overwhelmingly on multiple-choice and short-answer items focused on recall of facts and execution of procedures. This stands in complete opposition to repeated calls from leading disciplinary organizations (National Council of Teachers of Mathematics, Mathematical Association of America, National Research Council) emphasizing conceptual understanding, strategic competence, mathematical reasoning, and problem-solving as the primary goals for instruction (National Council of Teachers of Mathematics, 1989; National Research Council, 2001, Lee & Son, 2022; Pinger et al., 2020).

Schoenfeld (2002) highlighted the exceedingly narrow range of knowledge and skills elicited, with the vast majority of questions targeting basic skills in numbers, operations, and arithmetic. Extended problem-solving sequences or opportunities for mathematical communication were strikingly absent. As such, he argued prevailing assessments offer "no indication that students can use mathematics in context, solve problems, or reason mathematically" despite broad consensus that such competencies constitute "What it means to do mathematics" (2002, p. 13). This profound disconnect means teaching to these widespread standardised measures results in an extreme emphasis on memorising procedures, formulas and computational fluency at the expense of developing students' deeper conceptual understanding. Schoenfeld (2002) stressed that this not only narrows the mathematical experience for students but can undermine success in higher-level mathematics pathways critical for Science, Technology, Engineering, and Mathematics (STEM) careers. The misalignment has persisted despite repeated issuances of research-based frameworks calling for a diversification of testing formats and content coverage beyond discrete basic skills and factual recall.

Progress in instruction and learning mathematics requires addressing what Schoenfeld labelled this "unhealthy situation" where external assessments severely limit opportunities for

demonstrating mathematical reasoning proficiency, problem formulation, investigative skills and communication fundamentals that disciplinary experts unanimously agree are essential aims for mathematics education. His critiques have been highly influential in motivating calls for revising standardised testing practices.

Similar to Schoenfeld's conclusions in the United States, South African mathematics experts have highlighted issues in external standardised assessments emphasising procedural skills over conceptual understanding and problem-solving ability aligned to curriculum aims (Schollar, 1988; Askew & Schoeman, 2010). Analyses of the Senior Certificate Examinations found a predominant focus on procedures and factual recall rather than applying understanding, mirroring issues raised with American tests (Bansilal, 2010). However, the specific assessments critiqued and proposed alternatives differ due to contrasting contexts. South African research has focused more on biases in the school leaving matric examinations and specialised assessments for qualifications used historically to restrict opportunities (Lolwana, 2017). Proposed alternatives integrate more formative assessment and discussion-based demonstrations of mathematical literacy aligned with socio-economic goals in the post-apartheid era (Hugo, 2017). There is also a greater emphasis on issues of inequity in access and outcomes on assessments as extensions of past discrimination.

Within other African nations, similar patterns emerge around the misalignment of high-stakes examinations like Kenya's Kenya Certificate of Secondary Education (KCSE) with goals of developing conceptual knowledge and flexible problem-solving skills (Abagi & Odipo, 2003). However, much greater concerns centre around access, resources gaps, and bias in exacerbating socio-economic divides (Krauss, 2016). The comparability of critiques around instructional relevance is complicated by even greater cultural and contextual differences in the conceptions of mathematical proficiency.

Seeking alternatives, Webb (1993, 1997) compared various assessment formats - including multiple choice, short response, constructed response, essay questions, oral examinations, and formative tasks - in their capacity to capture standards, including conceptual understanding, problem solving, mathematical communication, and reasoning highlighted across expert recommendations (NCTM, 1989, 1995). The findings revealed that best practices in mathematics assessment should utilise diverse item types tapping into the authentic application of knowledge and skills (Webb et al., 1997). Calls have amplified for exploring innovative formative assessments in mathematics aligned with meaning-making over rote memorisation

(Goldberg & Roswell, 2000; Santos & Semana, 2015). However, multiple studies point to challenges in embedding formative assessment sustainably within the demands of daily mathematics teaching.

Firstly, consistency issues emerge as teachers tailor informal checks to the moment, struggling to document and track patterns (Grossman et al., 2010). Reliability research shows subjectivity and variability in documenting student exchanges or work undermine precision (Bennett, 2011). Secondly, practical barriers around class time, content coverage pressures, and recourse intensity constrain daily integration, often relegating to periodic practice (Heritage et al., 2009). Gaps persist between the formative assessment capacities envisioned by teachers and feasible reality within fast-paced classrooms (Dixson & Worrell, 2016). Scholars also argued the ways mathematics is often taught in schools as ritualised and disconnected from meaning or real-world application. Davis (1988) contends that in many classrooms, mathematics bears little resemblance to the actual discipline, instead becoming a set of abstract rituals for manipulating odd symbols on paper. For students, these rituals frequently feel meaningless, turning even straightforward equations into confusing symbols they seek to evade. Similarly, McNeill (1988) reflects on his own experience as a competent student losing motivation for mathematics in high school due to its seeming irrelevance. Joffe (1993) also found mismatches between school mathematics and practical mathematics used in everyday situations, noting many students struggle academically yet capably apply mathematical concepts informally outside school (Omodan et al., 2022; Eshetu et al., 2021).

Some experts argue that instruction should emphasise mathematics as more than amassing skills and facts. Brodie (1991) advocates rewarding students' logical reasoning ability over just locating the right answers. He claims that teaching should highlight how mathematics enables deeper analysis of real problems, not just mastery of procedures. Addressing constraints around scoring consistency, documentation, and comparability remains critical for meaningful implementation.

2.8 Translating policy into classroom practice

Implementing interactive, process-focused assessments relies on teacher skill and understanding (Vandeyar & Killen, 2007). Yet research reveals assessment literacy deficits among teachers (Hariparsad, 2004). If teachers lack abilities to leverage assessment to enhance learning, teacher training programmes bear the responsibility to cultivate expertise through modelling and practice (Xu & Brown, 2016).

Several qualitative studies have examined how South African educators make sense of shifting national assessment policies amidst shifting mixed messages and environments of limited change capacity. Dieltiens and Sayed (2013) utilised extensive surveys and interviews across 40 schools over time to examine mathematics teachers' responses to C2005's mandates on formative assessment. They found that the majority of educators maintained focus on preparing learners specifically for final examinations as the perceived end goal, only using newer project or portfolio approaches periodically. Teachers admitted feeling confused by vague guidelines and overwhelmed by workloads so made minimal effort to implement alternative assessments more regularly, continuing just isolated use of year-end assessment controlling student advancement opportunities (Dieltiens & Sayed, 2013). These beliefs limited more meaningful shifts even years after the reforms.

Equally Kanjee and Sayed (2013) employed a mixed methods approach across multiple provinces specifically investigating teachers' conceptions of the role of formative assessment in classrooms. Then, 72% of interviewees saw assessment predominantly as an accountability mechanism for grading and gate-keeping learner progress rather than supporting improved instruction as emphasised in policies. Observation data showed questioning, feedback and other formative techniques implemented very minimally during instruction. The study concluded contradictory messages on assessment purposes across C2005, the NCS and teacher preparation drove narrow interpretations as check listing rather than utilising continuous evidence to benefit learning. Spreen and Vally's (2010) used mixed-methods research in Gauteng and KwaZulu Natal which pointed to an inadequate understanding of assessment policy. Besides, 96% of surveyed teachers identified barriers to translating C2005/NCS requirements into practice. Interviews and observations revealed that educators were aware of expected formative assessment but unable to implement it amidst lack of model materials, guidance documents or examples for reference hampering the conception of feasible approaches to teaching.

Additionally, Hoadley (2018) conducted an in-depth qualitative study of assessment policy enactment across grade 9 English, Mathematics, and Social Sciences classrooms. Observations and interviews found "very little evidence of teachers collecting and using data" from alternative assessments like projects for feedback (p.97). Summative test preparation dominated, with token use of learner profiles, self-assessments, or investigations only as supplemental activities rather than meaningful integration due to sticking to habitual practice. Teachers expressed wanting to incorporate more formative assessment but lacking time,

exemplars, or moderation support to do so appropriately amidst pressure to cover content. Hoadley's (2018) study foregrounded that all the teachers struggled to uphold assessment consistency, record-keeping and moderation without adequate systems.

Similarly, a set of case studies by De Klerk (2015) in Western Cape primary schools found educators "battle to keep up" with assessment policy adjustments (p.34). Interviews highlighted feelings of being inadequately prepared to shift ingrained attitudes on testing as account-giving rather than a pedagogic technique. Observations showed that the teachers inconsistently adopted fragments of reforms like peer assessment add-ons but resisted discarding deep-rooted traditional monitoring methods. They alternated between periods of intensified attempted compliance and abandonment depending on shifting signals, without synthesising recommendations into daily practice.

Workload and time intensification also hampered efforts amidst high-stakes examination pressure (Dita, 2017). Weaker content and pedagogical knowledge undermined designing quality classroom assessments (Pryor & Lubisi, 2002). Conflicting messages led to fatigue, with teachers "fed up" amidst inadequate support (Mabogoane & Patel, 2018, Mpofu et al., 2021; Sibanda & Graven, 2021). Such barriers fostered superficial adoption at best, with teachers admitting, "We speak the language, but do not practice it" regarding assessment reforms (Spreen & Vally, 2010, p.41).

Therefore, studies exposing limited educator understanding of formative assessment abound globally (Amoako, Asamoah & Bortey, 2019; Arumugham et al., 2017), including elementary teachers (Harris, 2016), high school teachers (Arrafii & Sumarni, 2018), and foundation phase teachers (Kanjee & Mthembu, 2015). Documented misconceptions construe formative assessment merely as monthly grading, testing/measurement, or supplemental activities rather than a seamless teaching-learning practice (Arumugham et al., 2017; Spector et al., 2016). Such impoverished understanding inhibits the actualisation of interactive formative assessment to support learning (Xu & Brown, 2016).

The National Council of Teachers of Mathematics endorsed integrating formative assessment into regular pedagogy to continuously diagnose student needs and provide tailored support (NCTM, 2014). However, effective implementation remains a challenge. In a U.S. study, Thacker (2016) found teacher application of formative practices, though evolving with experience, fell short of seamless integration into continuous instruction. Similarly, Cisterna and Gotwals (2018) determined that while teachers enacted some formative components, they

struggled to actualise a cohesive approach aligning evidence gathering, interpretation, and responsive instruction. These findings echo Black and Wiliam's (2009) seminal work revealing the benefits of formative assessment often failing to materialise in practice due to deficiencies in teacher skill and school-level cultural factors inhibiting adoption. Indeed, Heritage (2007) underscored that infrastructure to support collaborative data analysis for decision-making represents a key yet often missing systemic ingredient.

Other literature signals teacher education programmes as a pivotal juncture. Xu and Brown (2016) highlighted classroom assessment literacy amongst instructors as imperative for developing preservice teachers' capacities to eventually implement formative assessment effectively in schools. Moon (2005) also called for explicit modelling of formative assessment in teacher training, arguing that beliefs and perceptions of assessment solidify during this period to profoundly shape eventual practice. Thus, instead of just teachers, turning focus "upstream" to explore teacher educators' embodiment of formative principles provides critical insight. Their knowledge constructions and modelling exert a strong influence on pupils' future practices (Lunenberg et al., 2007). Uncovering potential gaps at this juncture holds significance for improving implementation school-wide.

Recent systematic reviews by Paul and Corter (2022) and Niemann et al. (2023) have synthesised a growing body of research on the challenges of policy implementation related to assessment reforms across various national contexts. Key obstacles identified include a lack of policy coherence across system levels, insufficient educator professional development support, weak buy-in from institutional school leadership, inadequate technology/infrastructure, a lack of structured collaboration time, and deficit orientations failing to leverage existing teacher capacities. The reviews suggest that systemic, capacity-building approaches are needed, not just trainer-of-trainers models.

However, research suggests assessment design challenges persist even as innovative formats emerge. In a comparative judgement study by Meadows and Black (2022), expert teacher raters showed wide variability in their evaluations of students' extended mathematics problem responses intended to tap into conceptual understanding. This raised validity concerns about the reliability of scoring such open-ended mathematics tasks across classrooms.

Furthermore, Rodriguez et al. (2022) found through teacher interviews that ensuring accessibility of innovative mathematics assessment items continues to be a barrier. Many teachers raised concerns about embedded linguistic complexity creating construct-irrelevant

challenges for English learners. There were also issues ensuring visual models and representations were culturally appropriate and avoided stereotypes. Such accessibility oversights undermine the validity of such assessments in capturing student mathematics understanding versus measuring external factors. Therefore, exploring the knowledge and practices of teacher educators who prepare preservice teachers is an urgent priority if practice is to shift.

2.9 Assessment in private schools

In South Africa, private schools are actively redefining their assessment practices, transitioning away from conventional summative assessments to embrace a more holistic and student-centred formative assessment approach (Vandeyar & Killen, 2007). This shift is underscored by the recognition of critical themes that significantly influence assessment methodologies within this context. Cultural considerations, emphasising the diverse cultural backgrounds and learning styles of students, play a pivotal role (Kanjee & Moloi, 2014). The impact of external assessments, likely encompassing standardised tests or examinations beyond the school level, is acknowledged as a key factor shaping assessment practices (Spaull, 2013). Additionally, technological integration is emphasised, incorporating digital tools and online platforms to enhance assessment methods (Schmahmann, 2013). Teacher professional development is deemed essential, ensuring educators are equipped with the skills and knowledge needed to implement the new assessment approach effectively (Xu & Brown, 2016). Moreover, the involvement of parents in the assessment process is recognised, highlighting the importance of collaborative efforts between schools and families (De Clercq et al., 2022). These transformative changes reflect a comprehensive understanding of private school education that prioritises individualised learning experiences and a broader development perspective (Taylor et al., 2013).

South African private schools generally operate within the parameters of national assessment standards outlined in CAPS and other guidance documents. For example, CAPS specifies that "Assessment is a continuous planned process of identifying, gathering and interpreting information about the performance of learners" (DBE, 2011, p. 290). It further states that "Assessment should be both informal (Assessment for Learning) and formal (Assessment of Learning)" (DBE, 2011, p. 290). The national curriculum frameworks emphasise continuous assessment through diverse strategies, monitoring of individual progress, and data-driven teaching adaptation. As CAPS guidelines assert, "The design of assessment tasks should cover the content of the subject...address a variety of skills...use various forms of assessment...and

different cognitive levels" (DBE, 2011, p. 290). These principles align closely with quality formative assessment.

School-Based Assessment (SBA) has been a cornerstone of South African assessment policy since 2002, further emphasized in the 2012 Curriculum and Assessment Policy Statement (CAPS). Recent studies by Kanjee (2020) and Govender and Mkhize (2021) highlight both progress and persistent challenges in SBA implementation. While the Department of Basic Education has refined policies to provide clearer guidelines and improve moderation processes, issues such as teacher workload, assessment literacy gaps, and equity concerns continue to impede effective implementation. Kanjee (2020) argues that SBA's formative potential often remains unrealized, with many teachers approaching it as mini-summative assessments rather than opportunities for ongoing feedback and learning. Govender and Mkhize (2021) note that moderation processes, while strengthened, tend to focus more on administrative compliance than on assessment quality. Both studies emphasize the critical need for targeted professional development to enhance teachers' capacity to design authentic, curriculum-aligned tasks and use assessment data to inform instruction. Recent policy initiatives encouraging technology integration in SBA practices face challenges due to unequal access to digital resources across schools. A key tension highlighted by Kanjee (2020) is balancing SBA's formative potential with its use for high-stakes decision-making, which can undermine its developmental aspects. Despite these challenges, SBA remains a vital component of the assessment landscape, with ongoing efforts to refine its implementation and realize its full potential in supporting student learning and development.

South African private schools are widely presumed to demonstrate superior assessment practices and adoption of progressive continuous models over public contexts. Analysts argue lower teacher-student ratios, selective resourcing, and strong accountability systems empower private institutions to better enact reforms (Soudien, 2007; Cantrell & Jansen, 2016). Some highlight privileged parental communities supporting investigations through networks and partnerships as positioning private schools to lead innovation (Ndlovu, 2014). However, such assertions remain largely anecdotal or theoretical with minimal empirical studies documenting enhanced classroom assessment implementation.

A few small qualitative studies profile ability tracking and learning analytics systems for data use in some private school contexts (Schmahmann, 2013; Swartz, 2009). Schmahmann's (2013) case study documented a specialised assessment initiative at a historically elite South African

girls' school. Serving less than 1% of the country's learners, this niche private institution implemented an extensive data-driven learning programme incorporating a digital profiling platform using quantitative performance results alongside attitudinal assessments to track individual progress, benchmark skills, diagnose obstacles, tailor instruction, and promote self-directed learning amongst their affluent students. The initiative harnessed extensive resources, like full-time academic data analysts, to facilitate a data-rich learning environment impossible for overburdened public schools to replicate at scale.

Similarly, Swartz's (2009) work profiled the psychometric student tracking systems leveraged at an exclusive historically White private school to optimise learning amongst top academic performers. The programme incorporated both cognitive ability and non-cognitive psychosocial assessments using personality tests, surveys, simulations and more alongside academic results to create multi-dimensional profiles of high-ability youth. Granular personalised data enhanced academic counselling, subject choices, intervention priorities, and instructional differentiation for students at this well-resourced school.

However, beyond such selective examples, there is little wider evidence on formative assessment conformity or researchers explicitly comparing contrasting school sectors. Large-scale studies aggregately profiling general resourcing advantages provide only indirect proxies regarding assessment capacities (Spaull, 2013). As Kanjee and Moloi (2014) highlighted in their policy analysis, “there is insufficient research on the different ways teachers conduct assessment on a daily basis” across school types (p. 13).

Consequently, substantive investigations examining if and how augmented resources and restricted enrolments translate into assessment gains within South African private schools present a significant research gap. Scholars underscore investigating such contrasts allows moving beyond assumptions to understand how material conditions shape assessment integration amidst shifting reforms (Hoadley, 2018). Especially since private institutions prominently promote superior progressiveness, scrutinising typologies and fidelity of internal assessment systems presents a public policy imperative to unpack long-term sector arguments around quality and exclusivity. While private schools in South Africa make bold pedagogical claims tied to resourcing privileges, detailed research examining their assessment models and enactment remains lacking but is urgently needed to inform wider debates on choice and public-private differentiation.

2.10 The gap and conclusion

The literature reviewed offers valuable insights into assessment practices in schools, particularly with a focus on formative assessment. Scholars such as Black and Wiliam (2009) underscore the importance of formative assessment in enhancing ongoing learning, a principle that resonates with the global educational discourse. Yet the literature asserts that understanding and practice of formative assessment remains a challenge, specifically in the teaching and learning of mathematics.

Despite the existing literature, there are notable gaps that this study aimed to address. Firstly, while there is a general understanding of the shift towards formative assessment, specific details regarding the implementation of formative assessment policies in South African private schools remain underexplored. The study intended to delve into the nuances of how private schools operationalise and adapt formative assessment strategies within their unique institutional contexts. Additionally, there is a need for more specific insights into the challenges and opportunities faced by private schools in this transition, shedding light on potential barriers and effective strategies for successful implementation.

2.11 Theoretical framework

A theoretical framework serves as the lens through which a researcher conceptualises and examines phenomena in context (Cohen, Manion & Morrison, 2011). The choice of framework connects to one's philosophical assumptions about the nature of knowledge and reality and informs methodological decisions (Williams & endogenous, 2020). By rendering researcher assumptions explicit, theory facilitates analysing and discussing how study variables interrelate (Cohen, Manion & Morrison, 2011).

Black and Wiliam's (2009) theory of formative assessment provides a robust framework for understanding and implementing effective assessment practices in mathematics classrooms. Unlike perspectives focused narrowly on the assessment of learning, their theory spotlights assessment for learning, casting it as integral to pedagogy rather than just evaluation after instruction (Cauley & endogenous, 2021). The framework’s five key teacher practices - clarifying learning intentions, eliciting evidence of learning, providing feedback, and activating self and peer assessment – structured examination of participants’ conceptions and use of formative assessment (Adapted from Black & Wiliam, 2009).

Black and Wiliam (1998) published their ground-breaking work on formative assessment in 1998. Through a meta-analysis of over 250 research studies on classroom assessment, they

developed a theory emphasising the importance of frequent, interactive formative assessment in enhancing student achievement. Black and Wiliam define formative assessment as follows:

> *Practice in a classroom is formative to the extent that evidence about student achievements is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited (Black and Wiliam, 2009, p.7).*

In their definition, they used the term 'instruction' to refer to any activity that is intended to create learning. It also focuses on the agents who are involved during the assessment and the use of the results to influence the decision about the subsequent instruction. In other words, assessment activities, involvement of teachers and learners, feedback and the use of feedback to improve teaching and learning are important in formative assessment. This contrasts with summative assessment, which evaluates learning at the end of a unit or grade. Black and Willams's theory explicates the key purpose, processes, and efficacy of assessment for learning rather than just assessment of learning. This would enable framing analysis of how teachers conceive of and operationalise formative assessment against established principles.

To provide a better theoretical grounding for formative assessment, Wiliam drew on Ramaprasad's (1983) three key processes in learning and teaching and the agents involved during the assessment. In developing their theory of formative assessment, Black and Wiliam (2009) combined the three processes of learning and teaching drawn from Ramaprasad (1983) with the different agents (teacher, peer, and learner) to develop the framework. These key processes in learning and teaching were, establishing where the learners are in their learning, establishing where they are going and establishing what needs to be done to get them there.

Establishing where the learners are in their learning refers to teachers diagnosing students' current levels of understanding. Determining students' current levels of understanding is essential for responsive teaching. As Heritage (2007) explains, "The first step in recognising students' learning needs is to identify the gap between their current learning state and the desired learning goal" (p.141). Questioning, discussion, and analysis of student work create opportunities for teachers to diagnose existing skills, knowledge gaps, misunderstandings, and difficulties (Black & Wiliam, 2009; Ruiz-Primo & Furtak, 2007). For example, Chin (2006) found open-ended questions and wait time reveal student thinking, while Franke et al. (2009) showed how teacher probing elicits explanations that provide insight into mathematical

understanding. Carefully designed pre-assessments and informal daily checks for understanding also enable teachers to establish what students already know in order to tailor instruction accordingly (Clark, 2011). Heritage (2007) stresses that understanding the students' starting points is an essential first step in guiding their ongoing learning**.**

Establishing where they are going refers to clarifying the intended learning goals and expectations. Clearly articulating intended learning outcomes provides students with a roadmap for learning. Learning intentions should identify the knowledge, conceptual understanding, and skills students will develop (Black & Wiliam, 2009; Brookhart, Moss & Long, 2010). Explicit learning objectives and success criteria establish goals and expectations transparently (Andrade & Brookhart, 2019). For example, Andrade and Boulay (2003) advocate co-constructing rubrics with students to clarify standards for quality work. Shared goals and criteria allow students to monitor their progress, check their work against standards, and take ownership of learning (Davies, 2006). However, several studies reveal teachers struggle to make outcomes clear to students, use overly complex language, or fail to engage students in understanding goals (Kirby & Downs, 2007; Reyneke et al., 2010). Explicitly communicating and discussing learning intentions are essential steps in framing formative assessment and guiding students forward.

Lastly, establishing what needs to be done to get them there requires teachers to design lessons, learning activities, and formative assessments to move students to the established goals. Once learning intentions are clear, teachers must design instructional strategies and formative assessments to move students toward these goals. As Heritage (2007) discusses, formative assessment should inform teaching adaptations and differentiation to meet learning needs. Ongoing evidence drawn from questioning, discussions, and varied assessments highlights where students are struggling (Black & Wiliam, 2009). Targeted feedback tailored to gaps in understanding identified through formative assessment provides students guidance on the next steps (Hattie & Timperley, 2007). For example, Franke et al. (2009) found that teacher probing and scaffolding help clarify mathematical thinking. When gaps persist, re-teaching content using new approaches, tools, and personalised support helps ensure students acquire the intended knowledge and skills (Clark, 2011). As Black and Wiliam (2003) emphasise, instruction must flexibly respond to assessment evidence in order to move students forward in their learning.

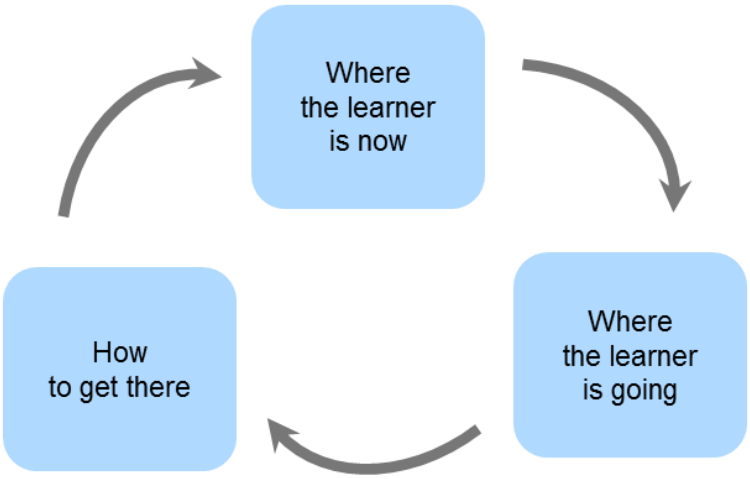

Figure 1: Assessment for learning loop (Ramaprasad (1983)

While the teacher is responsible for designing and preparing an environment conducive for teaching and learning, it is also important to take into account the role that the learners themselves and their peers play in learning. Hence Black and Wiliam (2009) suggested a theoretical framework for formative assessment by combining these three processes in teaching and learning with the different agents (teacher, learner, and peer) of teaching and learning. They indicate that formative assessment can be conceptualised as consisting of five key strategies (Black & Wiliam, 2009, p.8).

FRAMEWORK RELATING FORMATIVE ASSESSMENT STRATEGIES TO INSTRUCTIONAL PROCESSES		
Where the learner is going	***Where the learner is right now***	***How to get there***
1 **Teacher: Clarifying learning intentions and criteria for success.**	**2** Engineering effective classroom discussions and tasks that elicit evidence of learning	**3** Providing feedback that moves learners forward

Peer: Understanding and Sharing learning intentions and criteria for success.	**4** Activating students as instructional resources for one another.
Learner: Understanding learning intentions and criteria for success	**5** Activating students as the owners of their learning.

Table 1: Five key activities of formative assessment **(**framework combines Ramaprasad (1983) three key instructional processes, three agents and Black and Wiliam's (2009) five activities of formative assessment**)**

The first strategy is clarifying and sharing learning intentions and criteria for success. Clarifying learning intentions and success criteria is foundational for enacting effective formative assessment. As Davies (2006) and Leahy et al. (2005) explain, transparent learning goals allow students to fully engage in and monitor their progress. Learning intentions should clearly articulate the knowledge, understanding, and skills students will develop (Black & Wiliam, 2009; Brookhart, Moss & Long, 2010). In mathematics education, this involves clearly communicating mathematical goals and success criteria. Chapman et al. (2021) found that when teachers explicitly shared learning intentions for mathematical concepts, students demonstrated improved problem-solving skills and conceptual understanding. This strategy aligns with the study's research question on teachers' understanding of formative assessment, as it requires educators to articulate clear mathematical objectives.

Where the learner is right now: Strategy 2: Engineering effective classroom discussions and tasks that elicit evidence of learning Strategy 5: Activating students as owners of their own learning These strategies focus on gathering evidence of students' current mathematical understanding. Tsatsa and Wessels (2023) demonstrated that open-ended mathematical tasks

and peer discussions allow teachers to gain insights into students' thinking processes and misconceptions. This relates directly to my research question on how teachers' understanding influences their classroom practices, as it requires designing and implementing activities that reveal student thinking.How to get there: Strategy 3: Providing feedback that moves learners forward and Strategy 4: Activating students as instructional resources for one another, involves using assessment information to guide future learning. In mathematics, this might include providing specific feedback on problem-solving strategies or facilitating peer tutoring on challenging concepts. Chapman et al. (2021) found that descriptive feedback focused on mathematical processes rather than just correct answers led to significant improvements in student performance.

By examining how teachers enact these strategies and processes, we can gain insights into:

1. Teachers' conceptual understanding of formative assessment in mathematics (Research Question 1): We will analyze how teachers interpret and articulate the five strategies and three processes in the context of mathematics instruction.
2. The translation of understanding into practice (Research Question 2): By observing classroom practices, we can identify how teachers implement these strategies, particularly in engineering tasks that elicit mathematical thinking and providing process-oriented feedback.

Recent research by Tsatsa and Wessels (2023) in South African mathematics classrooms has shown that teachers who effectively implement these formative assessment strategies see improvements in students' mathematical reasoning and problem-solving abilities. However, they also note challenges in consistently applying these practices, particularly in diverse classroom settings.

By using Black and Wiliam's framework as a lens for this study, I can systematically examine the alignment between teachers' theoretical understanding and practical implementation of formative assessment in mathematics. This approach will allow me to identify areas of strength and opportunities for growth in formative assessment practices, contributing to the broader understanding of effective mathematics pedagogy in South African primary schools.

2.12. Conclusion

This chapter reviewed the literature relevant to my study and discussed the theoretical framework that underpinned this study. The gaps in the literature review and the relevance of the theoretical framework were well documented in the context of this study. In the next chapter, I described and discussed the research design and methodology applied to this study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter reviewed the literature on formative assessment, teachers' perceptions of formative assessment and how these perceptions interact with teachers' assessment practices. It also presented the theoretical framework – Black and Wilian (2009) – that was used to make sense of the findings. In this chapter, the research design and methodology used in this study were explained and discussed. Detailed explanations about the research paradigm, sampling method, data analysis, ethics considerations and limitations of this study were succinctly outlined.

3.2 Research paradigm: Interpretivism

The concept of a research paradigm has been extensively explored by scholars as a system of beliefs that guides a researcher's actions (Lather, 2006; Lincoln et al., 2011; Creswell & Creswell, 2018). As described by Guba and Lincoln (1994), a research paradigm represents the basic set of beliefs that shape an individual's worldview and define their perspective on reality. It serves as the foundational framework that informs a researcher's approach to their study (Mackenzie & Knipe, 2006). A research paradigm encapsulates the researcher's ontological, epistemological, and methodological assumptions, which collectively influence their understanding of truth and knowledge (Scotland, 2012, Denzin & Lincoln, 2018)). This paradigmatic stance shapes the researcher's thoughts, values, and beliefs regarding the research study (Creswell & Poth, 2018).

Scholars emphasised that a researcher's paradigm is a reflection of their fundamental principles regarding the nature of reality (Creswell & Creswell, 2018; Mertens, 2015). Consequently, the paradigm adopted by a researcher serves as a guiding force in determining the methodological procedures employed throughout the investigation, data collection, and analysis processes (Kivunja & Kuyini, 2017; Kuhn, 1962; Punch, 2014). The paradigm acts as a lens through which the researcher perceives and interprets the phenomena under study, ultimately shaping the entire research endeavour (Ponterotto, 2005; Teddlie & Tashakkori, 2009).

For this qualitative study, an interpretive research paradigm provided a well-suited philosophical lens. The interpretive paradigm centres on understanding how individuals construct meaning and make sense of their lived realities within particular social contexts (Willis, 2007; Schwandt, 1994). As Thanh and Thanh (2015) describe that this paradigm recognises that knowledge and meaningful interpretations of phenomena are socially constructed through people's subjective experiences and perspectives.

Examining grade 4 teachers' conceptualisations of formative assessment aligns with the interpretive paradigm's ontological assumptions that there are multiple, mind-dependent realities shaped by individual sensemaking (Guba & Lincoln, 1994). Teachers' understanding of formative assessment's relationship to mathematics teaching at the specific private school reflected their unique constructions of this phenomenon based on experiences and contexts. An interpretive stance allowed for accessing and analysing these distinct perspectives teachers form about formative assessment practice.

The interpretive paradigm was further fitting for studying the enactment of teachers' professed formative assessment literacies in practice through its emphasis on understanding behaviours as they unfold in authentic, real-world settings (Reeves & Hedberg, 2003). Observing how grade 4 teachers integrate formative techniques like questioning, feedback, and self/peer assessment during actual mathematics lessons provides critical contextual insight into this paradigm's axioms that cognition and action are socially and culturally embedded (Bevir & Kedar, 2008).

Methodologically, the interpretive paradigm enabled and necessitated the use of qualitative techniques like interviews and observations to richly capture the teachers' sensemaking around the complex phenomena under study (Denzin & Lincoln, 2011; Creswell, 2013). This paradigm's inductive, context-sensitive nature aligned with developing grounded, emic understandings of how teachers construct knowledge and integrate formative assessment specifically within the bounded case of their private school mathematics classrooms (Stake, 1995). An interpretive lens guides interpreting participants' perspectives and behaviours through their own experiential lenses and sociocultural positionings as the basis for building understanding.

3.3 Qualitative research approach

Qualitative research possesses discrete characteristics: it examines phenomena within authentic real-world settings, provides participants with a platform to express their perspectives, considers the contextual backdrop in which participants are situated, and relies on diverse sources of evidence to enhance the accuracy and credibility of findings (Yin, 2011). Unlike its quantitative counterpart, qualitative research aims to examine and understand the experiences and perspectives of research participants (Krauss, 2005, Cohen, Manion & Morrison, 2018). It analyses a particular phenomenon and how participants act, react or conceptualise that phenomenon in an authentic (real) world setting (Krauss, 2005). Given that my research objectives were exploring grade 4 teachers' understanding of formative assessment in mathematics and their corresponding practices, the qualitative research approach presented itself as a sufficient and justified option for my study.

Qualitative research possesses discrete characteristics: it examines phenomena within authentic real-world settings, provides participants with a platform to express their perspectives, considers the contextual backdrop in which participants are situated, and relies on diverse sources of evidence to enhance the accuracy and credibility of findings (Yin, 2011). Unlike other research paradigms, qualitative research delves into participants' comprehension of their realities, emphasising their viewpoints over the researcher's values and interpretations (Krauss, 2005). Hence, for this study, qualitative research was apt, as it uniquely attends to the contextual factors shaping participants' behaviour in specific situations, a dimension often overlooked by other paradigms. Furthermore, qualitative research not only interprets phenomena using existing concepts but also fosters the creation of new conceptual frameworks (Yin, 2011), striving to conceptualise intricate social processes. Given the intricate nature of real-world environments and the diversity among participants, utilising varied sources of evidence such as observations and semi-structured interviews becomes imperative when trying to enhance the research's reliability and credibility. This research study was primarily focused on meaning and sought to explore grade 4 teachers' understandings and practices of formative assessment as related to the subject area of mathematics with their specific backgrounds and teaching context. Interactions in this study occurred during semi-structured interviews and classroom observations. Semi-structured interviews offered me insight into my participants' understandings of formative assessment, and the classroom observations garnered me relevant data to their practices of formative assessment.

3.4 The Research design

For this qualitative study, a case study design is an appropriate and advantageous approach. As Yin (2018) defines it, a case study allows an in-depth investigation of a contemporary phenomenon within its real-world context, especially when the boundaries between the phenomenon and context are intertwined. Examining grade 4 teachers' formative assessment understanding and practice represented such a bounded case where classroom practices are intricately linked to the specific private school setting.

A key strength of case studies is enabling rich, contextualised understandings through multiple data sources (Stake, 1995). This study's use of semi-structured interviews and classroom observations facilitated triangulating teachers' espoused perspectives on formative assessment with evidence of their actual enacted behaviours during mathematics teaching. Such a design supports comprehensively exploring the complex relationships between the educators' formative assessment understandings, school environments, and pedagogical decisions in authentic classroom contexts (Merriam, 2009).

Moreover, the case study approach in this research resonated with the study's objectives of exploring grade 4 teachers' understanding of assessment in mathematics and how this understanding influences their classroom assessment practices. By observing authentic lessons and conducting semi-structured interviews, the study aimed to delve into how the selected teachers' practices related to their conceptual understandings at the specific case site. This depth of exploration facilitated building grounded interpretations of the phenomena under study, aligning with Stake's (2005) perspective on case study research.

While limited in generalisability beyond the case boundaries, case study findings can still elucidate wider conceptual insights to be further tested (Yin, 2018). For this study, analysing a single instrumental case of a private school mathematics context holds the potential to raise implications regarding formative assessment enactment, affordances and constraints that can inform future enquiries across school types. The depth and contextualisation enabled through the case study design support meeting this research's central aims.

To uphold rigour, the study utilised established case study protocol and maintained a chain of evidence through systematic data documentation, triangulation, member checking, and reflexivity (Stake, 1995; Yin, 2018). While subjectivity is inherent, these techniques enhance the credibility and transferability of findings for maximum leverage of the case study approach.

Overall, a case study frame was well-matched for this interpretive examination of grade 4 teachers' formative assessment understandings and practices.

3.5 Data collection instruments

In qualitative research, the process of data collection is focused on gaining insights into how participants construct meaning and make sense of their experiences and realities (Creswell & Poth, 2018; Merriam & Tisdell, 2016). Data generation involves gathering information through direct interaction with participants, allowing researchers to capture their perspectives, interpretations, and narratives (Flick, 2018; Lichtman, 2013).

In this study, two primary techniques were employed to facilitate the generation of rich, in-depth data: semi-structured interviews and classroom observations (Dörnyei, 2007; Stake, 1995). These methods enabled me to engage directly with participants, fostering a dialogic exchange and providing opportunities for direct observation of their practices (Creswell & Plano Clark, 2011; Patton, 2015).

3.5.1 Semi-structured interviews

Semi-structured interviews were conducted with teachers teaching Grade 4 mathematics at a selected private school. This interview method is widely acknowledged as a prevalent data collection approach in qualitative research (Patton, 2015; Suter, 2020). Kvale and Brinkmann (2009) describe a semi- structured interview as a two-way dialogue, where the interviewer poses questions to the participants to elicit their perspectives, beliefs, opinions, and behaviours. The primary objective is to understand the participants' worldview and their construction of knowledge and reality within their specific context.

Rubin and Rubin (2012) characterise a semi-structured interview as an exchange of viewpoints between two or more individuals on a topic of mutual interest, aimed at generating new knowledge. This view is further reinforced by Seidman (2013), who posits that interviews are an effective means of gaining insight into educational and social issues by comprehending the lived experiences of individuals whose lives reflect those issues. Seidman (2013) also highlights that semi-structured interviews align with how people construct meaning through language. From the researcher's perspective, semi-structured interviews allowed the participants to express themselves freely and transparently regarding their understanding of a particular social phenomenon.

Simons (2009, p.43) outlines several purposes of semi-structured interviews: firstly, to establish an individual's perspectives on a specific social issue; secondly, to facilitate active

engagement and learning as issues are identified and analysed; and thirdly, to allow flexibility in exploring emerging topics and probing for deeper insights from the participants' viewpoints. Additionally, semi-structured interviews have the potential to uncover unobserved feelings and experiences that cannot be directly observed. Ary et al. (2014) articulate this idea clearly: "A semi-structured interview has the advantage of rapidly yielding large amounts of in-depth data, providing insights into participants' perspectives, the meaning of events for the individuals involved, information about the site, and perhaps uncovering unanticipated issues." The underlying notion is that semi-structured interviews offer flexibility, enabling the researcher to promptly follow up on points and seek clarification from participants' responses. Cohen et al. (2018) share a similar viewpoint with Simons (2009) and Ary et al. (2014), stating that the advantages of semi-structured interviews include the ability to delve deeper into the enquiry and probe for more comprehensive data, as well as establishing and maintaining rapport with participants and gauging when rapport has not been achieved.

Based on the aforementioned purposes and advantages of interviews, the researcher employed a semi-structured interview as the primary data collection instrument for this study.

3.5.2 The Pilot study

Prior to commencing the actual data collection process, the researcher conducted a pilot study. The decision to undertake a pilot study was based on the recognised value it holds in the research process. According to Ary et al. (2014), a pilot study is a trial run of the study with a small number of participants to assess the appropriateness and feasibility of the research process and the data collection instruments. Creswell and Poth (2018) corroborate this view, stating that conducting a pilot study is an effective way of improving the research as it allows the researcher to learn from their mistakes. It helps the researcher to experiment with different questioning styles, developing confidence and proficiency in handling the actual research interviews or observations. As Kim (2011) suggests, a pilot study enhances the validity, reliability, and practicality of the study. Furthermore, it assists the researcher in familiarising themselves with the project they are pursuing. In essence, a pilot study is a crucial part of the research process, as it enables the researcher to modify the research instruments as necessary to obtain more valid data.

During the piloting of the data collection instruments for this study, the researcher interviewed three grade 4 teachers and observed one mathematics lesson with teachers who had experience teaching grade 4 at an urban private school. The purpose of the pilot study was to determine if

the questions were clear and what they were intended to ask of the participants. The researcher then used the data gathered from the pilot study to establish if the data from the actual study was relevant to the research questions. From the pilot study, the researcher identified potential challenges that could arise during the actual data collection process. This helped the researcher modify the questions by reducing the number of questions, as some essentially asked the same question using different wording, and by rephrasing closed and judgemental questions to be more open and non-judgemental.

After analysing the pilot study data, the researcher discovered that some important aspects regarding the understanding and practice of formative assessment in mathematics were missing. Consequently, the interview guide for the actual study was modified accordingly. The researcher was able to break down the questions into fewer simple, open-ended statements that allowed participants to elaborate on the issues. I also realised that the questions were asked rapidly, and participants were not given enough time to reflect on their pedagogical practices to provide detailed insights. From the pilot study, the researcher learnt to proceed more slowly as he asked the questions, allowing participants ample time to think carefully before responding.

3.5.3 Process for conducting the semi-structured interviews

The semi-structured interviews primarily centred on the teachers' understanding of formative assessment in the teaching of mathematics. The interview schedule consisted of ten key questions. During the interviews, the researcher took note of all verbal and non-verbal cues exhibited by the teachers (participants), such as facial expressions, gestures, tone of voice, and overall body language, as suggested by Merriam and Tisdell (2016). The researcher enquired about the teachers' preferred language for the interviews, and they all chose to use English, which became the medium of communication throughout the interview process. The researcher also requested permission to audio-record the interviews, which was granted by the participants to ensure that no information was missed. Handwritten notes were also taken as a backup to the audio recordings.

Prior to commencing the interviews, the researcher explained the purpose of the interviews to the participants and made them aware of their ethical obligations. He clarified that they had the right to remain in the study or withdraw at any point without consequences. Consent forms were then signed by the participants. The researcher established a positive rapport with all the participants by engaging in a brief, general conversation about the appearance of their school

and the sports activities they offered. This served as a warm-up session, allowing the researcher to develop a rapport with the interviewees. Moreover, the researcher remained mindful of respecting the participants' emotions throughout the interview process. Since the interviews were conducted after school hours, the researcher periodically paused during the interviews to check if the teachers were still comfortable continuing, and they all affirmed their willingness to proceed. As a result, the interviews progressed smoothly until their conclusion.

The interview questions encompassed a range of question types, from straightforward enquiries to more complex questions that required participants to reflect on their practices to provide clear responses. The researcher allowed for brief pauses and rephrased questions when necessary to elicit more detailed responses from the participants. A relaxed atmosphere was maintained between the researcher and the participants by giving them adequate time to express their views on each issue. However, the researcher remained vigilant in preventing them from straying too far from the focus of the questions. This was important to consider as Cohen et al. (2018) and Ary et al. (2014) assert that during interviews, it is easy to be sidetracked by trivial matters irrelevant to the study. Hence in instances where participants deviated from the research questions, the researcher tactfully guided them back to the relevant topics without causing offence. Transcriptions of the audio recordings were completed on the same day as the interviews, while the researcher's memory was still fresh. The interviews lasted for 45 minutes. Once all the semi-structured interviews were concluded and transcribed, the researcher conducted classroom observations.

3.5.4 Classroom observations

Classroom observations were another data collection tool utilised to gain deeper insights into the phenomenon under investigation. Mills and Morton (2013) assert that observation is a systematic process of recording participants' behavioural patterns, objects, and occurrences without necessarily questioning or communicating with them directly. Creswell and Poth (2018) share a similar view, stating that observation is a data collection method where participants' behaviour is observed in their natural settings, providing the researcher with first-hand experiences of their daily lives.

In this study, classroom observations helped capture the real-life experiences of grade 4 teachers in their mathematics teaching context. All activities that the teachers engaged in with their learners were observed firsthand. The researcher assumed the role of a non-participant observer, which enabled him to gain an understanding based on direct experiences rather than second-hand accounts, which might be biased for various reasons.

3.5.5 Advantages of using classroom observations

Utilising lesson observations as a data collection tool offers several advantages. In this study, lesson observations provided the researcher with a detailed and clearer perspective of the problem being investigated. It also allowed the researcher to experience the real-life teaching of mathematics as he witnessed every action that unfolded during the lessons.

Moreover, the classroom lessons conducted in this study allowed the researcher to observe participants' attitudes and actions in their natural settings, aiming to comprehend the phenomenon of formative assessment in mathematics teaching from the teachers' perspective (Berg & Lune, 2017). This approach aligns with Kawulich's (2005) suggestion that researchers should immerse themselves in the event to capture participants' behaviour authentically. By gathering data from classroom lessons, the study obtained crucial supplementary insights into how grade 4 teachers understand assessment in the mathematics learning area and how this understanding influences their classroom assessment practices.

3.5.6 Procedure for classroom observations

The researcher observed mathematics lessons that included various activities, such as problem-solving tasks, group work, and individual tasks and assignments in three grade 4 classrooms at the selected private school. Three visits were made to each class on different dates. The topics of the lessons observed were planned by the teachers themselves.

The researcher assumed a non-participant observer's stance in the classrooms. The teachers and learners were aware of his presence, but he did not participate in the classroom activities. For this study, a lesson observation tool was prepared based on the findings from the literature review regarding effective formative assessment practices in mathematics education and factors that influenced the implementation of formative assessment at this level. The observation schedule was also guided by the theoretical framework used in the study. The classroom observations focused on three main aspects: the general appearance of the classroom (physical environment), the personal or human behaviour (classroom atmosphere), and the interactional aspect (interaction between teacher and learners). The researcher had a classroom observation schedule for each class attended that assisted him in maintaining the purpose and focus of the observations. This guide was linked to the research questions guiding the study, as suggested by Merriam and Tisdell (2016). The researcher conducted a pilot study using the same lesson observation schedule to observe one grade 4 mathematics lesson in the same

school. This pilot observation lasted for one hour and provided the researcher with an opportunity to reflect on the suitability of this data collection tool for the study. It also enabled him to gain confidence in recording all observable behaviours in the classroom and making sense of the observations.

Table 2: Classroom Observation Guide

<table>
<tr><th>Context</th><th colspan="2">Focal areas for observations</th></tr>
<tr><td>Physical</td><td colspan="2">Physical appearance of the classroom; arrangement of desks; availability of chalkboard, notice board, shelves, charts, flashcards, books, and worksheets.
Rules employed in the classroom.</td></tr>
<tr><td>Personal</td><td colspan="2">The composition of the class, general behaviour, and co-operation with the teacher and peers.
Ways in which the teacher conversed with the learners and how the learners approached the teacher.
Interpersonal formative activities used to develop mathematics literacy in the students.</td></tr>
<tr><td rowspan="2">Interactional</td><td colspan="2">The actual teaching-learning activities, formal and informal interactions between teacher and students, and peers</td></tr>
<tr><td>Formative Assessment Techniques</td><td>Observe how teachers integrate formative assessment practices into their regular instructional routines.
Look for instances where teachers use techniques such as questioning, observation, discussion, and feedback to gather insights into students' understanding.
Note the types of formative assessment tasks or activities used</td></tr>
</table>

	(exit tickets, quizzes, group work, and individual work, etc.).
Alignment with Learning Goals	• Observe how teachers' formative assessment practices align with the broader curriculum goals and standards for mathematics learning in grade 4. • Look for instances where teachers assess students' understanding of key mathematical concepts, skills, and processes outlined in the curriculum. • Note how teachers use formative assessment to monitor and support students' progress towards meeting these learning goals.
Differentiation and Personalisation	• Observe how teachers use formative assessment data to differentiate their instruction and provide personalised guidance to students. • Look for instances where teachers adapt their teaching strategies or resources based on individual students' needs or learning gaps identified through formative assessment. • Note how teachers balance addressing individual needs while ensuring that the entire class

		progresses towards the learning goals.
	Student Engagement and Articulation	• Observe how teachers involve students in the formative assessment process. • Look for instances where teachers encourage students to articulate their thinking processes, problem-solving approaches, and reasoning. • Note how teachers use student articulation as a formative assessment tool to gain insights into their understanding and address misconceptions.
	Feedback, Next Steps and Assessment	• Observe the types of feedback teachers provide to students based on the formative assessment data. • Look for instances where teachers provide descriptive feedback that clarifies students' current understanding and provides guidance for future learning. • Note how teachers communicate feedback and next steps to students, and how they involve students in setting goals or planning for their learning based on assessment information.

Table 2 shows the researcher's focus during observations in grade 4 mathematics classrooms. This guide helped to keep the researcher focused on the purpose of the study.

The proposed classroom observation schedule was designed to gain a comprehensive understanding of how grade 4 teachers' understanding of assessment influences their practice of classroom assessment in mathematics. This schedule was significant to the research as it provided a structured approach to collecting data that directly addressed the research question.

The schedule was divided into three distinct categories, each focusing on a specific aspect of formative assessment practices and their connection to teachers' understanding of assessment.

The first category is the physical classroom environment, including the arrangement of desks, availability of resources (e.g., chalkboards, charts, manipulatives), and overall organisation, which can either facilitate or hinder hands-on, interactive learning activities that are crucial for formative assessment (Black & Wiliam, 1998; Moss & Brookhart, 2019). A well-organised and resource-rich environment can support collaborative work, small group discussions, and the use of manipulatives, which are essential for gathering formative assessment data on students' conceptual understanding and problem-solving approaches.

The second one is the interpersonal dynamics between teachers and students, including the level of rapport, respect, and open communication, which plays a vital role in creating an environment conducive to formative assessment (Heritage, 2007). When students feel comfortable and respected, they are more likely to actively participate in formative assessment activities, articulate their thinking processes, and be receptive to feedback and guidance from the teacher. Positive teacher-student interactions can foster trust and encourage students to take risks, ask questions, and engage in constructive self-assessment, all of which are essential for effective formative assessment (Wiliam, 2011).

The third aspect is the "Interactional approach," which is divided into six distinct categories. The first subcategory is "Formative Assessment Techniques and Practices" which aims to observe how teachers integrate formative assessment practices into their regular teaching practices (Black & Wiliam, 1998). This includes observing the various techniques and tasks used by teachers to gather insights into students' understanding, such as questioning, observation, discussion, feedback, quizzes, exit tickets, group work, and individual work.

The second sub-category, "Alignment with Learning Goals and Assessment," focuses on how teachers' formative assessment practices align with the broader curriculum goals and standards

for mathematics learning in grade 4 (Moss & Brookhart, 2019). This category is crucial in understanding how teachers use formative assessment to monitor and support students' progress towards meeting these learning goals.

The third sub-category, "Differentiation, Personalisation, and Assessment," explores how teachers use formative assessment data to differentiate their teaching and provide personalised guidance to students (Heritage, 2007). This category is significant in understanding how teachers adapt their teaching strategies, resources, and assessment methods based on individual students' needs or learning gaps identified through formative assessment.

The fourth sub-category, "Student Engagement, Articulation, and Assessment," examines how teachers involve students in the formative assessment process (Wiliam, 2011). This includes observing instances where teachers encourage students to articulate their thinking processes, problem-solving approaches, and reasoning, and how teachers use this articulation as a formative assessment tool to gain insights into students' understanding and address misconceptions.

The fifth and final subcategory, "Feedback, Next Steps, and Assessment," focuses on the types of feedback teachers provide to students based on the formative assessment data (Black & Wiliam, 1998; Moss & Brookhart, 2019). This category is essential in understanding how teachers provide descriptive feedback that clarifies students' current understanding and provides guidance for future learning, as well as how teachers communicate feedback and next steps to students based on assessment information.

3.5.7 Conducting the classroom observations

For recording the observations, the researcher followed the advice of Merriam and Tisdell (2016) to capture two dimensions: the description of what was observed and the reflections on what had happened. This template served as the researcher's reflective journal, where entries were made during each classroom visit. The researcher recorded what was observed during the mathematics lessons, including what was said and done and how the events unfolded, as well as the researcher's thoughts and reflections on the observations. The researcher made every effort to document everything that took place during the lessons so that valuable conclusions could be drawn from the observations.

Date and Time	Situation	Participant(s)	Action Observed	Reflection

Table 3: Observation Record

Table 3 illustrates how the researcher recorded data during the classroom observations. This approach ensured that the researcher kept records of what had happened, where, when, and by whom. It also showed how the researcher viewed each observed action through his own reflections on the events.

At the end of each lesson, the researcher had a brief discussion with the teacher about the lesson and their intentions in delivering it. The teachers' lesson plans were also informally viewed to understand the lesson objectives, classroom activities, and teaching methods used. The researcher was interested in observing how closely the teacher's actual lesson delivery aligned with the planned lesson in their preparation books. The researcher then performed a thematic analysis of the observation data collected.

3.5.8 Challenges encountered during classroom observations

One major challenge encountered during the classroom observations was that, in the first lesson, both the teachers and the learners were not entirely at ease with the researcher's presence in their classrooms. The teachers seemed to try to present a 'perfect' classroom environment, with strict order and cooperation, which rendered their lessons somewhat 'artificial' for grade 4 learners, as the behaviour displayed was not typical of students at that level. They appeared to be less spontaneous. The researcher believed that because he was also a teacher in the same school, this could have been intimidating for the teachers initially, and they might have feared that the researcher was on a fault-finding mission, despite numerous assurances that this was not the purpose. However, as they became accustomed to the researcher's presence in their lessons, they became less anxious and allowed the lessons to flow more naturally. The researcher made a conscious effort to remain neutral and avoid becoming emotionally attached to the participants.

3.6 Measures to ensure the trustworthiness of the study

In qualitative research, ensuring trustworthiness is paramount to establish the rigor and quality of the study. Trustworthiness encompasses four key components: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). This study employed several strategies to address each of these components.

Credibility refers to the confidence in the truth of the findings and interpretations. To enhance credibility, this study utilized triangulation, member checking, and prolonged engagement. Multiple data collection methods, including semi-structured interviews and classroom observations, were used to corroborate findings. Participants were given the opportunity to review interview transcripts and preliminary findings to ensure accurate representation of their perspectives. The researcher spent extended time in the research setting, conducting multiple classroom observations to gain a deep understanding of the context.

Transferability concerns the applicability of findings to other contexts. To facilitate transferability, the study provided thick descriptions and employed purposive sampling. Detailed accounts of the research context, participants, and data collection procedures were recorded, allowing readers to assess the applicability of findings to their own settings. Participants were carefully selected based on criteria relevant to the research questions, ensuring rich, informative data.

Dependability relates to the consistency and repeatability of the findings. To address dependability, the researcher maintained an audit trail and engaged in peer debriefing. Detailed records of the research process, including raw data, analysis notes, and methodological decisions, were kept. Regular discussions with colleagues and supervisors helped identify potential biases and ensure consistent interpretations.

Confirmability concerns the extent to which the findings are shaped by participants rather than researcher bias. To enhance confirmability, reflexivity was practiced and an audit trail was provided. The researcher maintained a reflective journal to examine personal assumptions and beliefs throughout the research process. Detailed documentation allowed for tracing findings back to original data sources.

Additionally, the researcher recorded thick descriptions of classroom observations, including verbal and non-verbal language of teachers and learners. A reflective journal was maintained after each lesson observation, clearly stating the specific focus and recording only relevant

observations. This approach aligns with Lincoln and Guba's (1985) recommendations for enhancing trustworthiness.

3.7 The Sampling approach

Sampling is a critical process in research that involves selecting a representative subset from a broader population of interest (Teddlie & Yu, 2007; Uprichard, 2013). It is the systematic approach of identifying and recruiting participants for a study in a manner that allows for generalisation to the larger group (Etikan et al., 2016; Stake, 2005). The purpose of sampling is to ensure that the data collected is reflective of the entire population, making it a fundamental aspect of any research endeavour (Gentles et al., 2015; Patton, 2015).

Scholars have emphasised that sampling is not merely a matter of convenience but rather a strategic decision-making process (Daniel, 2012; Saunders et al., 2018). Researchers must carefully consider various factors that can impact the sampling process, such as the study's context, time constraints, accessibility to participants, and practical limitations like costs and resources (Palinkas et al., 2015; Robinson, 2014). The specific sampling approach chosen should align with the research objectives and enable the generation of rich, relevant data that can provide meaningful insights into the phenomenon under investigation (Guest et al., 2017; Malterud et al., 2016).

By employing appropriate sampling techniques, researchers can ensure that their study is representative, reliable, and valid, ultimately enhancing the quality and credibility of their findings (Morse, 2015; Patton, 2002). The sampling process is therefore a critical component that requires careful consideration and justification, as it lays the foundation for the successful execution of any research project (Merriam & Tisdell, 2016; Yin, 2018)

This study employed a purposive and convenient sampling approach, which was appropriate as the researcher aimed to understand the phenomenon of grade 4 teachers' understanding and practice of formative assessment in mathematics at a private school. A small group of teachers with firsthand knowledge about the phenomenon of interest were selected to participate in this study.

Since this was a case study, the researcher recognised that the sample size was not a primary concern. The objective was not to make generalisations but rather to gain an in-depth understanding of the case from individuals who had direct experience with the phenomenon in their natural setting. This aligns with the assertions of Merriam and Tisdell (2016) regarding qualitative case study research. The researcher's goal was to acquire a comprehensive

understanding of the phenomenon. Consequently, two data collection methods, semi-structured interviews and classroom observations, were utilised to obtain a clearer picture of the case under investigation. The researcher believed that focusing on three grade 4 teachers from a single private school would provide an in-depth understanding of their understanding and practice of formative assessment in mathematics. The aim was to enquire extensively into the phenomenon, reflect on the findings, and describe as vividly as possible what was said and observed.

Convenience sampling, a non-probability sampling technique, involves selecting participants based on their availability, willingness to participate, and ease of access (Etikan & Bala, 2017; Ruel et al., 2016). This method is particularly useful when resources, time, and geographical constraints limit the researcher's ability to employ more rigorous sampling methods (Jager et al., 2017; Valerio et al., 2016).

The choice of three grade 4 mathematics teachers at a private school in Gauteng was also due to the availability of specific aspects discussed below.

- The researcher is formally employment as a grade 5 teacher in the same school as the participants and has access to the research site. The researcher's formal employment as a grade 5 teacher provides him with direct access to the research site, minimising travel costs and logistical challenges associated with conducting research in an external setting. This proximity allowed for seamless integration of research activities into daily teaching responsibilities, enhancing the efficiency of data collection and analysis.

- The researcher had built a meaningful and long-standing relationship with the teacher participants, which enabled the researcher to navigate sensitive research topics effectively. Trust and rapport established over time can facilitate open communication, honest feedback, and deeper insights into participants' perspectives on assessment practices within the school.

- The participant’s willingness to take part in my study. The willingness of teacher participants to take part in the study reflects their commitment to professional development and collaborative enquiry. Their active engagement can enrich the research process by providing diverse viewpoints, experiences, and practices related to formative assessment in mathematics education.

By using my convenient availability within the school environment, the researcher conducted research that was contextually grounded, responsive to participants' needs, and aligned with the realities of classroom s (Cohen, Manion & Morrison, 2018). This embedded approach to research allows for real-time data collection, immediate feedback loops, and iterative refinement of research questions based on emerging insights.

It must be noted that in the context of conducting research as a Grade 5 teacher within the same school, the researcher's positionality is significantly influenced by factors such as formal employment in the school, established relationships with teacher participants, and their willingness to engage in the study. While these aspects offer advantages in terms of accessibility, trust, and cooperation, they also introduce potential biases that need to be addressed to ensure the integrity and validity of the research.

As a grade 5 teacher with pre-existing relationships with participants, there is a risk of confirmation bias, where the researcher may interpret data in a way that confirms their existing beliefs or expectations. To overcome confirmation bias, the researcher engaged in reflexivity by critically reflecting on their assumptions and actively seeking contradictory evidence. Additionally, involving external peers and supervisors in data analysis provided alternative perspectives. Given the established rapport with participants, there may be a tendency for participants to respond in ways they perceive as socially desirable rather than providing honest feedback. To mitigate social desirability bias, the researcher emphasised confidentiality and anonymity in data collection, ensuring that participants feel comfortable expressing their genuine opinions without fear of judgement or repercussions. Finally, the convenience sampling method based on availability within the school may lead to selection bias, where certain groups or individuals are overrepresented or underrepresented in the study. To address selection bias, the researcher clearly defined inclusion criteria and strived to include diverse perspectives by purposively selecting participants from different experiences within the school (Cohen, Manion & Morrison, 2018).

While convenience sampling may not always provide a representative sample of the entire learner population, it can still offer valuable insights and inform pedagogical strategies effectively. Researchers can use this method strategically to gather relevant data quickly and make informed decisions that benefit learners learning outcomes (Cohen, Manion & Morrison, 2018).

Hence the combination of convenience and purposive sampling strategies allowed me to efficiently gather rich data from participants who were committed to finding solutions for improving curriculum differentiation in the foundation phase (Gentles et al., 2015; Robinson, 2014). Ultimately, the purposive and convenience sampling approach facilitated effective data collection within the available time and resource constraints, enabling the researcher to explore teachers' perceptions and assessment practices in a meaningful way (Mackenzie et al., 2006; Stake, 2005).

3.8 Selection of participant criteria

Three grade 4 teachers from a private school were purposively selected for this study because they were directly involved in teaching mathematics and implementing formative assessment strategies at that grade level. These teachers possessed firsthand knowledge and experience with the phenomenon under investigation. Teacher (A) John has taught mathematics for nine years. Teacher (B) Emily has twenty-two years of teaching experience and has taught mathematics for nine of them. Teacher (C) Sophia has been teaching mathematics for twenty-four years. All the three teachers were proficient in English, and the interviews were conducted primarily in English. The teachers and the researcher agreed to hold the interviews after school hours to avoid disrupting classes.

Name	**Teaching Experience (All Subjects)**	**Grade**	**Teaching Experience (Mathematics)**
Teacher (A) John	9	4&5	9
Teacher (B) Emily	22	4&5	9
Teacher (C) Sophia	24	4&5	24

Table 4: Participant information

3.9 Data analysis

The most essential underpinning for qualitative research is that there should be transparency and openness at all stages of data collection and analysis (Scott et al., 2005). Braun & Clarke's (2006) six-phase framework was used to conduct its thematic analysis of teacher assessment perceptions and practices. This phased process enables rigorous, systematic analysis facilitating robust qualitative exploration of phenomena through text, actions, and artifacts. It

surfaces insights beyond simple summary. Braun and Clarke (2006) delineated a widely-used framework to systematically engage in rigorous thematic analysis through six phases:

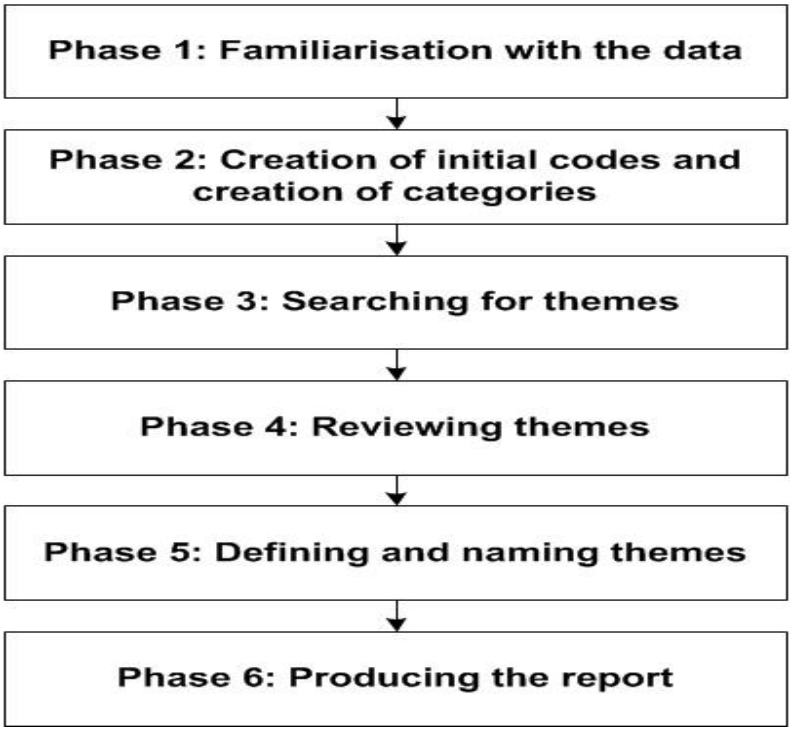

Figure 2: Thematic analysis phases (adapted from Braun and Clarke, 2006).

1. *Familiarisation with data*: Immersing oneself in the data requires repeated active reading of transcripts, listening to audio recordings, and watching video data, to mention a few. The researcher took notes on early impressions while deeply engaging with the accounts firsthand, laying the foundation for analysis (Braun & Clarke, 2006). The researcher read thoroughly through the semi-structured interview transcripts to immerse himself in teachers' expressed perspectives on formative assessment alongside repeated observation of teachers' lessons to directly assess pedagogical approaches in classroom settings.

2. *Generating initial codes*: Coding is the pivotal process of identifying features of the data that appear interesting and meaningful in relation to the research questions. Extracts of text were tagged with descriptive codes summarising why they seemed significant (Braun & Clarke, 2006). Systematically coding across the entire dataset enabled the researcher to organise data into meaningful groups to support pattern identification. Interesting quotes from teachers on themes like monitoring student

progress or short descriptions of practices like the use of exit tickets were systematically coded across interviews and observation notes to compare statements about intentions to actualised classroom techniques.

3. *Searching for themes*: A theme captures something critical about the research questions within the coded extracts and dataset. Theme search is an active process of pattern identification rather than passively emerging (Braun & Clarke, 2006). The researcher examined codes/data to ideate themes using visual representations like thematic maps reflecting relationships between codes, categories and sub-themes up to the main overarching themes (Braun & Clarke, 2006). The researcher classified codes into potential themes like "Formative assessment conceptual comprehension vs. application" illuminating relationships between teachers' demonstrated understanding versus inconsistent practices signalling room for formative assessment growth to support responsive teaching.

4. *Reviewing themes:* Potential themes undergo refinement and strengthening. The researcher reviewed collated extracts for each theme to consider whether they form a coherent meaningful pattern. If needed, themes and sub-themes were reconfigured into an interpretative narrative addressing the overall story about the research question phenomena emerging from the data insights. Potential thematic maps classifying codes into core themes underwent refinement to solidify themes like "Assessment for accountability purposes rather than for pedagogical adaptation and advancement." The researcher validated themes formed in coherent, meaningful patterns.

5. *Defining and naming themes*: Conducting detailed analysis involves identifying the essence and boundaries of what each theme entails in the context of the overall analysis in relation to the original research questions. Clear definitions and concise names were crafted to capture thematic significance. Clear names, definitions and detailed analysis explained what each theme, like "Over-reliance on observational inferences over student articulation," illustrated in terms of research questions regarding influences on assessment strategies chosen in this research.

6. *Producing the report*: All essential analytic work comes together in this final stage where the narrative is formed highlighting data-driven arguments in relation to the literature and research questions. A concise logical scholarly account was composed using vivid extract examples of diverse analytic lenses applied. In this research, the

final scholarly report featured compelling excerpts from teacher statements and vignettes from observation notes analysing formative assessment interpretation gaps and influences on underleveraged responsive pedagogical techniques relative to literature.

Rigorously progressing through Braun and Clarke's (2006) framework enabled robust analysis of qualitative data on assessment perceptions and practices generating research-backed recommendations.

3.10 Research ethics

Maintaining ethical standards is of paramount importance in any research endeavour, whether qualitative or quantitative. As Johnson and Christensen (2019) emphasise, research ethics are a set of principles that guide the researcher throughout the research project. These principles direct the conduct of the researcher to avoid any physical, emotional, or psychological harm that may be caused while working with people involved in the study. Researchers must be sensitive to ethical considerations in choosing topics and data collection methods.

To ensure adherence to ethical standards in this study, the researcher took the following measures: He explained to the participants in the study the purpose of the research, the nature of the semi-structured interviews, and the classroom observations. Letters in English were sent to the parents of the children whose mathematics lessons were observed, and they were provided with a consent form to read. A letter of consent was also sent to the school governing body and the principal of the school. The letter explained the purpose of the study and the research process.

The researcher also made it clear to the participants that they were free to withdraw from the study at any time without any consequences. The anonymity of the participants and the school was guaranteed. Convenient dates and times for the interviews were arranged with each grade 4 teacher, and telephone calls were made to confirm the schedule for the interviews and classroom observations.

Furthermore, the researcher obtained ethical clearance from the University of the Witwatersrand before commencing the data collection process. This ensured that the study adhered to the university's ethical guidelines and standards for conducting research involving human participants.

Researchers agree that strict adherence to ethical standards in planning and conducting research is of utmost importance, as researchers have an obligation to their participants and their profession (Creswell & Poth, 2018; Merriam & Tisdell, 2016). By following these ethical procedures, the researcher demonstrated a commitment to protecting the rights, dignity, and well-being of the participants while upholding the integrity of the research process.

3.11 Chapter summary

This chapter presented a detailed research methodology that was employed in this study. The research design and data collection methods used were outlined, and a rationale for their selection was provided. This research design served as a framework to integrate theory, research, and practice. The literature review enabled the researcher to identify an appropriate methodology for this study and develop suitable data-gathering tools that would yield rich, detailed data for comprehensive analysis. The research design facilitated an exploratory, investigative, and participatory approach in a natural setting.

This chapter also explained the rationale for the selection of participants and data-gathering tools. Furthermore, it outlined the measures taken to ensure the credibility and dependability of the study, as well as the ethical considerations observed.

The next chapter will provide a comprehensive presentation of the data and a discussion of the findings derived from the data collection instruments utilised, namely semi-structured interviews and classroom observations.

CHAPTER 4

DATA ANALYSIS

4.1 Introduction

The previous chapter outlined the research methodology and design which underpinned this study. This chapter presented data produced through semi-structured interviews and classroom observations conducted with three grade 4 mathematics teachers at a private school in South Africa. The aim was to gain insight into teachers' understanding of formative assessment and to explore the extent of alignment between their understandings and practices.

The research questions were as follows: *What are grade 4 teachers' understanding of assessment as it relates to the mathematics learning area? How does grade 4 teachers' understanding of assessment influence their practice of classroom assessment as it relates to the mathematics learning area?*

In this study, the researcher adopted the interpretive paradigm, and used a qualitative approach and a case study as the research design. A semi-structured interview was the tool used to answer the first research question of grade 4 teachers' understanding of assessment as it relates to the mathematics learning area and classroom observation was used to answer the second research question of how grade 4 teachers' understanding of assessment influence their practice of classroom assessment as it relates to the mathematics learning area. The findings from the semi-structured interviews and classroom observations were then discussed by the use of thematic analysis using Braun and Clarke's (2006) analytical framework of analysis. The data was first coded inductively, allowing themes to emerge from the data itself rather than forcing it into pre-existing categories. Codes were then organised into overarching themes that captured key phenomena relating to the relationship between teachers' understanding of formative assessment and their classroom practices.

4.2 Research question 1: What are grade 4 teachers' understanding of assessment as it relates to the mathematics learning area?

Three main themes emerged from the analysis: 1) Practical Applications and Real-World Connections, 2) Formative Assessment for Monitoring and Guiding Conceptual Understanding and 3). The third theme is teacher's difficulties in applying formative assessment. Within theme 1 and 2, subthemes emerged. Teachers' quotations are presented to illustrate the key findings.

4.2.1 Theme 1: Practical applications and real-world connections

This theme reflects the teachers' emphasis on the practical nature of mathematics and the importance of connecting mathematical concepts to real-world contexts. Two subthemes emerged under this overarching idea.

4.2.1.1 Subtheme 1.1: Hands-on learning experiences

The teachers demonstrated a clear understanding of the importance of hands-on, interactive learning experiences in mathematics education. They recognised that simply teaching or solving equations on the board is insufficient for fostering deep conceptual understanding and engagement among learners.

John asserted:"Engaging learners in hands-on activities is key in mathematics. When they can physically interact with materials and see math concepts come to life, it really helps strengthen their understanding. I try to incorporate manipulatives, models, and even real-world examples whenever I can. For instance, when teaching addition and subtraction, I use place value blocks to let students physically model adding two 4-digit numbers."

John's statement highlights the importance of practical, tactile experiences in mathematics learning. He emphasizes allowing learners to physically interact with materials, suggesting that concrete experiences help solidify abstract mathematical ideas. John's approach of using manipulatives before introducing formal algorithms provides a crucial foundation for conceptual understanding. By allowing active experimentation and questioning, John aims to strengthen students' intuitive number sense rather than relying on decontextualized memorization.

Similarly, Emily asserted: "*I believe that mathematics should be taught through exploration and discovery. Providing learners with hands-on activities and materials allows them to construct their own understanding of concepts rather than just being told the rules or procedures. For example, when teaching 2D shapes, I give students various quadrilaterals to explore and sort, asking them guiding questions about their properties."*

Emily's quote advocates for a constructivist approach to learning mathematics. She emphasizes the importance of allowing learners to actively construct their understanding through hands-on experiences rather than passively receiving information. By using concrete materials and guiding questions, Emily facilitates a discovery process that helps students develop deeper conceptual understanding. This approach encourages learners to take ownership of their

learning, cementing mathematical concepts through active exploration rather than rote memorization of rules and procedures.

Teacher Sophia maintains, *"I've found that using real-life examples and having learners work through practical problems in groups or pairs increases their engagement and comprehension. It's not just about teaching and solving equations on the board – they need to actively apply the concepts. For instance, when teaching simple equations, I use story problems like 'Thabo had some marbles, got 15 more, and now has 27. How many did he start with?"*

Sophia's approach emphasizes situating mathematics learning within authentic, relatable contexts. By using real-life examples and collaborative problem-solving, she creates an environment where students actively apply mathematical concepts, enhancing engagement and deepening comprehension. This method allows learners to understand the relevance of mathematics in real situations, moving beyond abstract equations. Sophia's strategy demonstrates her understanding that effective mathematics instruction requires contextual problem-solving to internalize algebraic concepts. By facilitating group work on practical problems, she promotes collaborative knowledge construction and exposes students to diverse thinking approaches.

All three teachers reject the traditional, lecture-based approach to teaching mathematics, recognising that, "*it's not just about lecturing and solving equations on the board."* Instead, they advocate for a more interactive, hands-on pedagogy that encourages learners to actively engage with the material, work collaboratively, and apply concepts to practical situations.

All the teachers share an understanding that formative assessment enables and enhances their interactive, hands-on pedagogical approach to teaching mathematics. Rather than relying on lectures, rote memorisation, and abstract examples, these teachers use tangible materials, real-world scenarios, and small group work to actively engage students in applying and discovering concepts. Within these hands-on lessons, the teachers emphasise questioning learners, listening to their thinking, observing their process, and checking their collaborative work products to gather ongoing insights into learner needs, preconceptions, and developing comprehension. These formative assessment data in turn equip the teachers to provide personalised guidance, address misconceptions, and modify activities to ultimately improve on learners' conceptual understanding. Hence the quotes reflect a conception of formative assessment as an integral support system underlying responsive, student-centred instruction - where evidence of learning

is continually gathered through hands-on engagement and purposefully utilised to advance enduring understanding for every learner.

4.2.1.2 Subtheme 1.2: Developing practical value and skills

The teachers' quotes further emphasised the role of assessment in developing and assessing the practical value and skills associated with mathematics. They recognised that assessments should go beyond testing procedural knowledge or content mastery and should instead focus on assessing learners' ability to apply mathematical concepts to real-world situations, engage in critical thinking, and problem-solving, and effectively communicate their mathematical reasoning.

Teacher John maintained, *"When it comes to assessment in mathematics, I really try to focus on more than just the numbers and formulas. I want to see if learners can take what they've learnt and apply it to real-world situations. For example, in a data handling task, I might give them information about their favorite sports and ask them to create graphs and calculate percentages."*

John's approach to assessment emphasizes moving beyond calculations and procedural fluency. He incorporates practical problems and case studies that require learners to apply mathematical knowledge to analyze data, make decisions, and solve complex issues. This method assesses learners' critical thinking abilities, communication skills, and understanding of mathematics' practical value. John's example of a data handling task demonstrates how he integrates real-world contexts into assessments, requiring students to connect mathematical concepts across various competencies. This approach aligns with a more comprehensive view of mathematical proficiency, focusing on the application of knowledge rather than isolated computational skills.

Teacher Emily also stated, *"You know, I believe assessments should reflect the skills we want our learners to develop, not just content mastery. Ummm, so in my assessments, I try to incorporate tasks that assess their problem-solving abilities, their capacity to reason logically, and their ability to use mathematics as a tool for understanding and addressing real-life challenges. I want to see if they can take abstract concepts and apply them practically, whether it's creating mathematical models, interpreting data, or using mathematics to justify decisions. These are the kinds of practical skills that will serve them well beyond the classroom."*

Teacher Emily emphasises that assessments should reflect the skills educators want their learners to develop, stating, *"I believe assessments should reflect the skills we want our learners to develop, not just content mastery."* They express a desire to assess learners' problem-solving

abilities," *"capacity to reason logically," and their ability to use mathematics as a tool for "understanding and addressing real-life challenges."* This quote suggests a focus on assessing practical skills such as creating mathematical models, interpreting data, and using mathematics to justify decisions – skills that have direct practical applications beyond the classroom setting.

Teacher Sophia shared, "*In my assessments, I try to go beyond just testing computational skills or memorised formulas. I want to see if learners can take the math they've learnt and actually use it to analyse real-world data, make predictions, or solve complex, multi-step problems. For instance, I might give them a problem about planning a community centre, where they need to calculate areas, determine possible building sizes, and evaluate feasibility."*

Sophia's approach to assessment challenges traditional practices focused on procedural fluency and rote memorization. She designs assessments that require learners to apply mathematical knowledge to authentic, real-world contexts. By using scenarios and case studies, Sophia assesses students' ability to transfer knowledge, make predictions, and solve complex problems. Her emphasis on justifying reasoning and communicating thought processes demonstrates a focus on higher-order thinking skills, such as critical analysis and logical problem-solving. Sophia's example of a multi-step area problem illustrates how she integrates multiple mathematical concepts, focusing on process skills like problem interpretation, strategic analysis, and solution feasibility. This approach reflects a commitment to assessing mathematical competence in a way that mirrors real-world applications and promotes deeper understanding.

Based on the theme of developing practical values and skills, the teachers share an understanding that formative assessment should evaluate more than just procedural fluency or factual knowledge. Instead, their assessments aim to provide insights into learners' ability to flexibly apply mathematical concepts to analyse real-world data, solve complex problems, justify solutions logically, and communicate mathematical thinking clearly. The teachers design authentic tasks and open-ended questions to invite higher-order thinking, assessing critical capabilities like logical reasoning, strategic planning, data interpretation, and mathematical modelling. By gathering evidence of these transferable competencies, the formative assessment enables teachers to pinpoint gaps in practical skill development for targeted reteaching. Additional modelling and scaffolded practice equip students to utilise mathematical knowledge meaningfully in novel scenarios. Hence these quotes reflect a conception of formative assessment as fuelling the advancement of versatile mathematical

literacy and evaluative proficiencies, not just formulaic mastery. The assessments promote enduring understandings and analytical habits of mind critical for future learning and participation in an information-based society.

4.2.2. Theme 2: Formative assessment for monitoring and guiding conceptual understanding

This theme focuses on the teachers' perceptions of formative assessment as a means to monitor learning progress, identify conceptual understandings or misunderstandings, and provide ongoing guidance to support meaningful learning in mathematics.

4.2.2.1 Subtheme 2.1: Monitoring the learning process

Teacher John stated: *"Formative assessment is so valuable because it allows me to really see where learners are in their learning journey. I'm not just looking for the right answer - I'm trying to understand their thought processes, the misconceptions they might have, and the areas they're struggling with. For example, when teaching volume, I have students work with actual containers, estimating and measuring capacities, then justifying their reasoning. I ask questions like 'What made you think this container would hold less?' to understand their thinking process."*

John emphasizes the value of formative assessment in providing insights into learners' thought processes, misconceptions, and areas of struggle. His approach focuses on understanding students' reasoning rather than just checking for correct answers. By continuously monitoring progress through hands-on tasks and targeted questioning, John can adjust his teaching to meet individual learner needs. His example of teaching volume concepts through practical activities demonstrates how he uses formative assessment to uncover students' intuitive understanding and misconceptions. This interactive, hands-on approach with embedded questioning allows John to gain deeper insights into learner thinking, enabling him to shape responsive teaching strategies. John's method reflects the use of formative assessment to advance conceptual development rather than relying solely on computational accuracy.

Teacher Emily shared, *"Umm, "I see formative assessment as a continuous dialogue between the teacher and the learner. It's about gathering ongoing feedback and insights into how they're grasping concepts, where the gaps are, and what preconceptions or prior knowledge they're bringing to the table. For example, in my lesson on 2D shapes, I ask questions like 'Why do we call this a triangle?' and observe group work, probing their thinking with questions like 'I notice you sorted these by colour. Can you explain how you are grouping them?'"*

Emily views formative assessment as an ongoing process of dialogue and feedback between teacher and learners. She emphasizes the importance of continuously gathering information about students' understanding, identifying knowledge gaps, and recognizing preconceptions or prior knowledge. Her example demonstrates how she integrates formative assessment throughout the lesson, using targeted questions and observations to gauge student understanding and identify misunderstandings. This approach allows Emily to adapt her teaching strategies, reteach concepts in different ways, and offer personalized guidance. Emily's method of using ongoing assessment strategically during lessons enables her to make informed decisions about who needs additional support or practice, reflecting a responsive and adaptive teaching approach.

Teacher Sophia explained, *"Because it (formative assessment) monitors and supports the learning process, especially when learners bring their own understanding about a particular topic given, the teacher can modify the work and give them a better way of understanding the particular solution effectively. For example, in a data interpretation lesson, I might ask learners to share what they know about different types of graphs, then guide them through creating and interpreting a bar graph of ice cream flavors, asking questions throughout to check understanding."*

Teacher Sophia's quote highlights the importance of formative assessment in monitoring the learning process, especially when learners bring their unique understandings to a particular topic. The teacher recognises that learners may have diverse perspectives and prior knowledge, and formative assessment allows them to identify these and modify their teaching accordingly, providing a "better way of understanding the particular solution effectively." For Teacher Sophia, the continuous checking for understanding allows her to monitor learners' learning on the spot and adjust teaching to meet their needs.

The teachers share an understanding that formative assessment enables them to continuously monitor learner learning and pinpoint gaps in comprehension. By analysing learners' thought processes, justifications, and responses to embedded questions, the teachers gain insights into misconceptions, diverse perspectives, and obstacles that may be hindering understanding. This real-time gathering of feedback allows the teachers to provide targeted support, personalised guidance, and responsive adaptations to address individual needs. Whether it is differentiating questioning based on readiness levels, modifying activities, revisiting concepts from new angles, or addressing inaccurate prior knowledge, the teachers use formative assessment data

to make pedagogical adjustments that will foster improved understanding for all learners. Their quotes reflect a conception of formative assessment as an integral tool for tracking conceptual development and identifying "better ways of understanding" so that instruction can be modified to maximise learning potential. Fundamentally, these teachers understand formative assessment as enabling learner-centred, growth-oriented teaching refined to meet emerging needs.

4.2.2.2. Subtheme 2.2: Adapting teaching and providing effective guidance

The teachers highlighted the role of formative assessment in enabling them to adapt their pedagogical approaches and provide more effective guidance to help learners grasp key mathematical concepts more deeply.

Teacher John asserted, "*The information I gather from formative assessments is invaluable in helping me tailor my teaching to learners' specific needs. If I notice that several students are struggling with a particular concept, I can reteach that topic using different strategies, examples, or representations that might resonate better with their understanding. Formative assessment gives me the flexibility to adjust my approach, rather than sticking tightly to a lesson plan."*

Teacher John's statement highlights the value of formative assessment in providing the necessary information to "*tailor teaching to learners' specific needs."* By identifying areas of struggle or misconceptions through formative assessments, the teacher can make informed decisions to "*reteach that topic using different strategies, examples, or representations"* that better resonate with students' understanding. This flexibility to "*adjust the approach*" based on formative assessment data allows teachers to move away from fixed, predetermined lesson plans and create a more responsive and personalised learning environment.

Teacher Emily claimed, *"Umm, formative assessment isn't just about identifying gaps in learners' knowledge – it also helps me understand their strengths and the areas where they're excelling. This allows me to provide more specific guidance and support where it's most needed, while also offering development opportunities for learners who have grasped the core concepts. It's about meeting each learner where they are and guiding them effectively towards deeper comprehension."*

Teacher Emily's quote emphasises the importance of formative assessment in not only identifying knowledge gaps but also in recognising learners' strengths and areas of excellence. This holistic understanding of learners' learning profiles enables teachers to *"provide more*

specific guidance and support where it's most needed," while also offering development opportunities for students who have grasped core concepts. The focus is on *"meeting each learner where they are"* and using formative assessment data to guide learners towards deeper comprehension in a tailored and effective manner.

Teacher Sophia stated, "*Through formative assessment, I can gather insights into the specific misconceptions or areas of confusion that learners might have. This allows me to address those issues directly and provide specific feedback or reteaching to help them overcome their misunderstandings. I can also identify the strategies that seem to work well for different learners and capitalise on those strengths to facilitate their conceptual growth more effectively."*

Teacher Sophia's statement reflects the use of formative assessment to gather insights into "*specific misconceptions or areas of confusion"* that learners might have. By directly addressing these issues through targeted feedback or reteaching, the teacher can help students overcome their misunderstandings more effectively. Additionally, by identifying the approaches or strategies that seem to work well for different learners, teachers can capitalise on these strengths to facilitate conceptual development in a more personalised and effective manner.

The teachers share an understanding that formative assessment enables them to gather detailed insights into individual learner needs in order to adapt instructional strategies accordingly. By surfacing common misconceptions, readiness levels, and areas of growth, formative assessment provides teachers with the feedback needed to reteach concepts using new approaches, examples, and entry points that better meet learners where they are. It also helps teachers identify what is working so they can leverage student strengths while addressing gaps with precision through targeted feedback and personalised guidance. Their quotes convey that formative assessment fuels responsive, differentiated, and learner-centred pedagogy refined to address the specific conceptual hurdles and leverage the specific developmental edge points of unique groups and individual learners. Fundamentally, these teachers view formative assessment as an essential tool for shaping adaptable, growth-oriented instruction catered to maximise each learner's advancement.

4.2.3 Theme 3: Difficulties in applying formative assessment

Whilst teachers did voice a good understanding of formative assessment, they also spoke of some challenges which existed in effective implantation implementation.

Teacher John stated, *"One major challenge I face is finding the time to effectively analyse all the formative assessment data I collect during lessons. With a class of 20 learners, it can be overwhelming to carefully review everyone's work. For example, in a hands-on measurement lesson, I struggled to process all the observations during class time. I ended up spending a lot of additional time after school reviewing group work samples to plan next steps. The time invested is valuable, but it can be a struggle."*

Teacher John's primary challenge lies in finding sufficient time to effectively analyse the formative assessment data collected during lessons. With a class size of 20 learners, the process of carefully reviewing each learner's work, observations, and responses to pinpoint their levels of understanding can be overwhelming and time-consuming. The hands-on measurement lesson example illustrates how the volume of data collected made it difficult to fully process and interpret the information during the lesson itself. Consequently, Teacher John had to invest significant additional time outside of class to thoroughly review the group work samples and anecdotal notes. While this investment of time is valuable for tailoring future lessons to meet learners' needs, the time constraints posed a practical challenge for Teacher John in implementing formative assessment effectively.

Teacher Emily echoed, "*A key challenge for me is managing the wide range of abilities and providing differentiated guidance based on the formative assessment information. For example, when teaching 2D shapes, some learners already understand the defining properties, while others struggle with basic vocabulary like vertices. Planning activities that meet all these diverse needs can be really difficult."*

For Teacher Emily, a key challenge lies in managing the wide range of abilities and diverse learning needs present within the classroom. The formative assessment data often revealed a spectrum of understanding among students, with some working above grade level and others struggling to grasp even basic concepts. This diversity made it difficult for Teacher Emily to provide differentiated guidance and instruction that effectively met the needs of all learners. Her example of teaching 2D shapes illustrates the complexity of addressing varied learner profiles simultaneously, highlighting the challenges involved in using formative assessment data to effectively differentiate instruction within the same classroom.

Similarly, Teacher Sophia maintained that "Interpreting learner responses and determining how to respond can sometimes be a challenge, especially for more abstract or open-ended tasks. For example, in data representation tasks, some learners struggled with creating accurate graphs.

But it wasn't always clear if the misunderstandings were about the graphing process itself, or the underlying concepts of categorising data and determining scales. I had to do additional questioning to get at the core of their misconceptions."

Teacher Sophia's challenge centred around the interpretation of learner responses, particularly for more abstract or open-ended formative assessment tasks. In the data representation example, some learners struggled with setting up and creating accurate graphs, but the underlying reasons for these misunderstandings were not always clear from the work samples alone. Teacher Sophia found it difficult to determine whether the issues stemmed from the graphing process itself or from a lack of understanding of more fundamental concepts. While the formative assessment provided evidence that learners were not meeting expectations, making instructional decisions based on this limited evidence was challenging. To address this, Teacher Sophia had to engage in additional questioning and probing to gain a deeper understanding of the root causes of learners' misconceptions, highlighting the complexity of interpreting formative assessment data and making appropriate pedagogical decisions.

Overall, the findings highlight that while teachers value formative assessment and its potential to inform and improve their teaching practices, they face various challenges in effectively implementing it. These challenges include time constraints, managing differentiation for diverse learner needs, and interpreting ambiguous or open-ended assessment data. Addressing these challenges likely requires a combination of strategies, such as careful planning, leveraging technology and collaborative support, and ongoing professional development in formative assessment practices.

4.3 Research Question 2: How do grade 4 teachers' understanding of assessment influence their practice of classroom assessment as it relates to the mathematics learning area at a private school?

Follow-up classroom observations were conducted after the semi-structured interviews with each of the three teachers. The observation explored the teachers’ practice of formative assessment. Data was collected through non-participant observations of 9 (3 each) lessons on numbers, operations and relationships for Term 2 which focuses on mental mathematics taught by three different teachers, John, Emily, and Sophia (pseudonyms used).

The study's focus on grade 4 lessons encompassing numbers, operations, and relationships for Term 2 emphasises on strengthening learners' mental mathematics proficiency. Examining formative assessment processes in this pivotal transitional year as learners further solidify

numerical foundations proves insightful, as grade 4 forms a critical juncture for consolidating basic number sense needed for subsequent skill development. As learner's build extensively on prior concepts, Term 2 presents an opportunity to evaluate both retained knowledge and evolving comprehension of operations and relationships among quantities. Mental mathematics fluency relies extensively on core numerical understanding but can prove difficult to accurately assess without formats granting visibility into learner thinking. Hence this domain allows apt analysis of how teachers leverage formative assessment to deepen understandings, assess and improve teaching strategies, and monitor skill acquisition.

Detailed field notes were taken during each 60-minute lesson, with a focus on recording all instances of formative assessment being used by the teacher. All observation notes and interview transcripts were analysed using thematic analysis as described by Braun and Clarke (2006). This approach involves familiarising yourself with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing a report.

The interview data revealed that all three teachers had a relatively robust conceptual understanding of formative assessment and its principles. They could articulate the purpose of using formative assessment to provide feedback to learners, adjust teaching, and uncover learning gaps and misconceptions, the observational data showed an inconsistent translation of these principles into practice through my observation.

Three key themes emerged from the analysis that provide insight into the research question:

- Strong conceptual understanding, inconsistent practice
- Assessment for learning vs assessment of learning
- Over-reliance on teacher observation versus learner articulation
- Good understanding of principles of formative feedback but missed opportunities for descriptive formative feedback

4.3.1 Theme 1: Strong conceptual understanding, inconsistent practice

Through my observation, teachers' practices showed a disconnect between teachers grasping formative assessment meaningfully in theory, while inadequately actualising that knowledge in frequent, skilful practice. While they grasped the ideas behind formative assessment and provided useful examples, this understanding did not consistently translate into practical application in the classroom. Their practices did not fully live up to the standards of their conceptual understanding.

The observation notes praise John's use of exit tickets at the end of the mental mathematics lesson on adding 3-digit numbers. John handed out notecards for students to jot down anonymous reflections on the question '*What was most confusing about mentally adding the 3-digit problems today?'* He was then able to categorise responses to identify that around a third of learners specifically struggled when having to carry numbers across multiple columns while adding in their heads. This exemplifies a formative assessment best practice that yielded tangible insights into students' emerging comprehension.

However, contrastingly, the observation of John's lessons also highlights missed chances to similarly uncover learner thinking. During the segment focused on multiplying 2-digit numbers like 30 x 50 mentally using place value strategies, John predominantly walked around and listened to students' oral responses. If errors were made, his level of feedback consisted only of statements like "*No, not quite right."*

John's use of some formative techniques combined with gaps where it could have been employed further reinforces the disconnect between conceptual knowledge and implementation. While he demonstrated some skills, the intermittent use of formative assessment within the context of the broader lessons indicates room for improvement.

In Emily's lesson, she also missed an opportunity for formative assessment during a similar independent work session. During her mathematics lesson on multiplication strategies, she devoted the latter half of the class to independent practice problems to reinforce the new concepts. As learners worked through problem sets multiplying 2- and 3-digit numbers individually in their workbooks, Emily slowly walked around the classroom monitoring their progress. However, the observation notes explicitly state that her method of monitoring focused only on the correctness of final answers rather than an assessment of the learner's actual understanding: As Emily looked over learners' papers, her only form of feedback were simple statements such as 'Yes, that's right' or 'No, check that one again.' At no point did she ask probing questions to have learners explain their steps, justify their approach, or elucidate their thinking process behind the multiplication algorithms.

This documentation indicates that Emily missed a prime opportunity to formatively gather data on learners' comprehension of the various multiplication strategies, not merely whether the final solutions ended up being right or wrong. There were no formal or informal checks for understanding built into this independent practice time. This exemplifies lost formative

assessment opportunities, with the independent practice standing in contradiction to Emily's stated perspectives on uncovering conceptual understanding versus merely judging accuracy.

Similarly, during Sophia's lesson on recognising place value and odd/even numbers, there were some creative tactics used but also missed eliciting chances. For example, she initially asked learners to use place value cards to build 4-digit numbers and identify which place positions were odd or even. Sophia asked probing questions like "*Why is the hundreds digit here odd?"* to assess understanding.

However, during the later mental activity, orally identifying if numbers recited randomly by Sophia were odd or even, she merely listened for correct responses without gathering insights into their mental classification strategies. When errors were made, like a student incorrectly saying 1 369 was an even number, she simply corrected answers without asking comprehension questions like:

"What approach did you take mentally to test if that number was odd or even?" "What about the 1 369 number was confusing when trying to quickly determine its odd/even status?"

While Sophia demonstrated an initial effective eliciting technique using place value cards, her assessment missed key opportunities to deeply evaluate learners' developing number sense around odd/even trends highlighted in the grade 4 curriculum. Seizing all chances to unearth mental mathematics processes remains key.

The observations indicate that while teachers demonstrated some insightful formative assessment practices, at times, there were significant missed opportunities to further probe and uncover learner thinking. Techniques like John's use of exit tickets and Sophia's initial place value questioning reflected strong formative assessment applications that yielded data on learner needs and perspectives. However, substantial lesson segments lacked purposeful checks for comprehension and relied predominantly on cursory judgments of accuracy. Instances of teachers walking around during independent work merely saying "right or wrong" without asking substantive questions exemplified lost eliciting chances. Even when errors surfaced indicating gaps, the corrections given failed to explore the underlying thinking or misconceptions. Thus, while select instances revealed skill, the intermittent, surface-level use without habitually seizing opportunities for deeper investigation of mental mathematics processes and problem-solving approaches signifies room for improvement. The strong conceptual grasp of formative assessment's aims consistently failed to manifest in thorough,

embedded practice. Bridging this theory-practice divide remains imperative for adjusting instruction based on an incisive reading of emerging learner understanding.

4.3.2 Theme 2: Assessment for learning vs assessment of learning

The data revealed some conflation between the concepts of assessment for learning (formative assessment) and assessment of learning (summative assessment). While the teachers articulated an understanding of formative assessment during interviews, some of their practices seemed more geared towards evaluating learning through quizzes and tests rather than using assessment formatively to adjust pedagogy.

In John's grade 4 mathematics lesson on multiplication of 2- and 3-digit numbers, he dedicated a full 20 minutes to reviewing missed concepts from a quiz conducted the prior week. Specifically, John projected several quiz questions onto the board that had very low overall pass rates from the learners. These involved word problems like:

"There are 324 learners participating in a chess tournament. If each school sent 27 learners, how many schools participated?"

John's approach here was not to use this sample question to actively check for new evidence of the learners' up-to-date understanding of multi-digit multiplication. Rather, he focused solely on walking the learners back through carrying to the different place value columns in the algorithm. His line of questioning reinforces the procedures rather than uncovering conceptual gaps. For example:

"He said 'Okay, we are going to walk through why we needed to carry over here...' without asking learners to explain or demonstrate their current comprehension."

This signifies John's conception of assessment being narrowly defined as the documentation and review of previous test performance. Despite new material on rounding before multiplying needing coverage per the national progression standards, he allocated substantial time to recycling past standardised questions without attempting to gauge learners' emerging mastery. His practice centres assessment over tracking dynamic comprehension against national mathematics expectations.

Emily’s lesson focused solely on test preparation questions related to the CAPS standards on estimation and number sense. The questions required learners to:

- Round 3- and 4-digit numbers to nearest 10, 100 and 1 000

- Estimate sums and differences of whole numbers including money
- Build up and break down 4-digit numbers using place value

Rather than interactively facilitating comprehension of strategies behind estimation, Emily only monitored right/wrong answers as learners worked independently. Her feedback included:

"*Good, you rounded that 3-digit number correctly" "No that estimate for the difference is too low".*

There were no probing questions asked such as:

"Explain your process in estimating that sum to the nearest 100" "How did you mentally break apart the 4-digit number using place value?"

The silent room besides pencils on paper showed no chances for learners to actively discuss or justify their evolving grasp of key estimation, decomposition and rounding concepts promoted by CAPS.

This narrow focus only on testing accuracy shows that assessment is treated as discrete answers, not a pedagogical strategy for learners' emerging computational flexibility and number sense. Deep assessment of mental strategies behind estimations remains imperative even amidst surface-level achievement on discrete test items. Appropriately, scaffolding development of core mathematical behaviours depends directly upon unearthing this behind-the-scenes sense-making.

The observation of Sophia's lesson on inverse operations indicated discrepancies in enacting formative assessments aligned with the curriculum. The 60-minute lesson occurred towards the end of a module on using addition/subtraction and multiplication/division as inverse operations to solve problems.

Sophia introduced the session by stating, *"We need to review everything on inverse operations before your test by reworking previous quiz questions."*

She proceeded to distribute a packet titled "Inverse Operations Review" involving word problems like:

- Using subtraction to check solutions to addition problems
- Finding the missing factor given a product and one factor

As learners worked silently, Sophia monitored mostly assessing accuracy - "*No, double check that"* without following up on shaky conceptual grasp of inverses. When a learner got stuck on using multiplication to check a division solution, Sophia simply showed the right way rather than probing the learner's comprehension.

No connections were explicitly made regarding patterns in inversely related operations - addition/subtraction or multiplication/division.

Overall, the review relied on individual test rehearsal rather than interactive eliciting of emerging mastery of leveraging flexible relationships between mathematical operations - a core CAPS expectation. Sophia's formative assessment contradictions illustrated assessment valued for summative performance rather than responsively nurturing conceptual potential on dynamic inverse operations.

The observations revealed contradictions between the teachers' stated perspectives on using assessment formatively to uncover understanding versus the prevalence of testing comprehension through grading quizzes and exit tickets. Substantial time spent reviewing past test questions without interactively probing the current grasp of concepts conveyed an emphasis on evaluations of learning over tracking developing knowledge against standards. Even when misconceptions surfaced, teachers often merely corrected answers rather than seizing chances to actively elicit thinking to pinpoint gaps. For example, John projected quiz problems on the board but failed to leverage them to uncover evolving multiplication strategies, while Emily monitored independent review work devoid of higher-order discussions. Sophia distributed test prep packets without adaptations based on emerging needs. The silent classrooms focused on individual test rehearsal signified lost opportunities to evaluate and advance conceptual growth on critical curriculum standards. Hence while teachers vocalised proper formative assessment purposes, observations conveyed assessment valued less for responsively nurturing potential than for scoring accumulated achievement. These contradictions between intended formative assessment aims and implementation centred around judging right/wrong answers signify an area for improvement towards entrenching assessment as an instructional compass rather than a mere performance audit.

4.3.3. Theme 3: Over-reliance on teacher observation versus learner articulation

The data indicated that while teachers often used observation of learner work and responses to monitor progress, they rarely asked probing questions to have students verbally articulate their thinking process and problem-solving approach. As such, much of the formative assessment

was confined to teachers' own inferences rather than directly accessing learners' emerging comprehension and gaps therein.

For John's lesson on multiplication strategies, he had students work independently to solve word problems using methods like repeated addition or break-down diagrams. For example:

"There are 35 learners going on a field trip. If each bus fits 12 learners, how many buses are needed? Show your working."

As learners worked, John walked around glancing at their progress in their notebooks. His feedback included vague praise like "*You're doing well"* or "*Check that step again."* However, there were no instances of John asking probing questions to understand learners' grasp, such as:

- "Explain why you chose that method?"
- "Take me through your steps in using repeated addition here."
- "Where exactly are you stuck with the break-down diagram strategy?"

This exemplifies a lost chance for rich assessment through pedagogical discourse per the lesson observation. Without directly eliciting learner thinking on multiplying large numbers as expected by grade 4 CAPS, John cannot gain insights into shaping responsive teaching according to precise comprehension difficulties contextually surfacing.

A similar observation occurred during Emily's lesson on utilising properties of operations, including commutative, associative, and distributive rules. This links directly to the CAPS progression requirements.

As learners worked through word problems adding and multiplying numbers, Emily noticed that a student incorrectly applied the distributive property to break apart (12 + 15) x 8 into 12 x 8 + 15 x 8. However, Emily merely stated the right series of steps without follow-up questions on his comprehension, such as:

"What was your understanding of using the distributive property to rewrite that multiplication expression?" "Where did your logic falter in properly distributing both terms inside the parentheses?" "Take me through your process so I can better support where your conception needs clarity."

Rather than leveraging this as an insight window into the learner's internalisation, Emily focused narrowly on output correction devoid of responsive scaffolding for principled understanding per expectations of CAPS. Probing key juncture moments remains essential to appropriately match instruction to emerging needs around properties-based arithmetic flexibility.

Sophia's lesson was addressed using an array model to explain multiplication concepts. As learners worked in pairs to draw out arrays representing problems like 5 x 12, Sophia walked around monitoring their progress. She noticed a group struggling to accurately sketch out the 5 x 12 array. However, rather than eliciting their thought process, Sophia jumped in stating, *"You made your rows going vertically but the number of rows needs to match the 5 groups."*

She proceeded to draw a corrected 12 by 5 array on their paper, yet there was no attempt to question the learners such as:

"Talk me through how you were thinking about structuring the rows and columns of your array." "What was unclear about properly relating the factors to the arrangement of groups?"

Without access to the rationale behind their misconstrued array, Sophia missed gathering data on comprehension gaps around utilising array models to demonstrate mathematical relationships. For formative benefits, surfacing learner thinking on visual representations and connections to factors proves essential even when accuracy issues surface.

This exemplified a tendency to overlook chances for insights through student articulation in favour of observational judgement devoid of responsive support tuned to conceptual hurdles. Prioritising learner disclosure through strategic questioning prevents instructional guesswork.

The observations revealed a heavy emphasis on teachers visually monitoring student work and answering questions rather than directly eliciting verbal explanations of problem-solving processes. While John glanced at students' written steps and Emily checked answers, neither seized chances to ask probing questions that unearth the rationale behind chosen methods or pinpoint logic gaps under error scenarios. Even noticing array miscues, Sophia corrected the sketch devoid of follow-up questions on array grouping comprehension. This pattern indicates formative assessment centred substantially on teachers' observational inferences - judging progress through outwards output alone - rather than insightfully accessing the 'behind the scenes' thinking through purposeful learner articulation. With conceptual grasp hidden inside 'black boxes,' responsive scaffolding proves hit-or-miss without strategic probing. Hence while

answer checks and observational scans offer partial glimpses into progress, maximising formative assessment's instruction-shaping potential relies upon making space for learners themselves to fully disclose emerging comprehension, self-evaluate approaches, identify sticking points, and reciprocally assist scaffolding responsive to intricacies of their reasoning. Prioritising such articulation prevents guesswork. Progress monitoring centred predominantly on performance accuracy devoid of elucidating sense-making processes risks pedagogical blindness to precarious missteps in conceptual frameworks ultimately underlying procedural manoeuvring central to mathematical dexterity. Unpacking cognition remains imperative.

4.3.4 Theme 4: Good understanding of descriptive feedback but missed opportunities for descriptive feedback

While teachers conveyed robust conceptions of utilising feedback formatively to advance understanding in the interviews, observations revealed narrow feedback missing chances to responsively build mathematical understanding. The observational data revealed that while teachers occasionally supplied some form of corrective feedback in response to learner errors or misconceptions, they predominantly failed to provide substantive descriptive feedback detailing students' current grasp to guide the next steps in learning.

In John's lesson on mental addition strategies, as learners shared their approaches to adding triple-digit numbers, his responses included only generic judgements like *"Good" or "Not quite."* Despite noticing Kates's inappropriate application of written algorithms for mental math, John responded simply by demonstrating the proper mental approach without descriptive details on why written procedures fail to demonstrate mastery of flexibility in mental operations central to the lesson aims.

The limited descriptive feedback exemplified in John's interactions reflects larger deficiencies in responsive scaffolding aligned to formative gaps noticed. For example, when Kate improperly applied written algorithms during the mental math activity, John stated, "*We don't need the full standard algorithm here. Let's use mental strategies more flexibly for these triple-digit problems."* However, his abrupt demonstration of a mental approach lacked elaborative clarity connecting specifically back to Kate's misstep and explaining why the written computation fails to build adaptive mental agility to efficiently partition numbers on the fly per the lesson aims. Opportunities were missed addressing Kate's reliance on engrained written procedures inhibiting the development of core number flexibility expected by grade 4.

Emily provided even less specificity in her limited feedback. During meaningful peer discussions analysing displayed sample responses to word problems, Emily largely neglected participating beyond periodic head nods and statements like "*That works"* or *"Check your operations."* Rather than seizing this as an opportunity to provide descriptive feedback clarifying effective elements in sample strategies or elaborating areas for refinement against expectations for modelling contextualised problems with diagrams, equations and well-labelled solutions, she supplied only tacit endorsements devoid of clarifying details aligned to standards.

Finally, Sophia only sporadically gave feedback, but when provided, lacked descriptive details. For example, in response to Liam's explanation of an error he made classifying 638 as an even number, Sophia merely restated, *"Remember numbers ending in 8 are even,"* without follow-up elaboration connecting to place value concepts or parity pattern generalisations helpful for reinforcing nuances behind determining odd versus even integers discussed in class - a missed chance.

The above observation exhibits teachers struggling to consistently provide substantive descriptive feedback, losing pivotal opportunities to reinforce well-aligned work or enhance partially accurate responses through precise details pinpointing current grasp in relation to standards and learning gaps requiring bolstered schemas. Teachers missed chances for strengthening present comprehension and nurturing advancement by situating feedback explicitly within the progression of endured understandings.

4.4 Conclusion

This chapter presented the findings of the study based on grade 4 teachers' understanding and practices of assessment in the mathematics learning area. Two critical questions guided the study: 1) What are grade 4 teachers' understanding of assessment as it relates to the mathematics learning area? 2) How do grade 4 teachers' understanding of assessment influence their practice of classroom assessment in mathematics?

Data were generated through semi-structured interviews and classroom observations. Several themes emerged from the inductive analysis of the data, including teachers' conceptualisation of assessment, the alignment between their understanding and practices, the challenges faced in implementing effective assessment strategies, and the strategies teachers believed could improve assessment practices in mathematics.

The findings from the semi-structured interviews revealed that all grade 4 teachers recognised the usefulness of formative assessment in guiding teaching and providing feedback. However, the study also identified challenges that teachers encountered in implementing assessment effectively, such as time constraints, managing differentiation, and interpreting assessment data.

The data from observations showed that teachers' assessment practices were often inconsistent with their stated understanding, with all teachers tending to rely heavily on summative assessments regardless of their conceptual grasp of formative assessment strategies. Even though the teachers articulated a more comprehensive view of assessment as a tool for guiding instruction and providing feedback, they rarely integrated formative assessment techniques effectively into their mathematics lessons.

The teachers agreed that improvements in assessment practices were needed, such as careful planning, leveraging technology and collaborative support, and ongoing professional development in formative assessment practices. The next and final chapter presents the researcher’s interpretation of the findings, the conclusions drawn from the findings and recommendations for action and further research.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1. Introduction

In the previous chapter, I analysed the data generated through semi-structured and lesson observation using thematic analysis. This chapter concludes the thesis by synthesising the core arguments and presenting my conclusions. In this chapter, I first outline a summary of the chapters in this study and discuss the findings of this study. Thereafter, I address some limitations of this study and offer suggestions for addressing the challenges that arise from the findings. Lastly, I provide recommendations for future research.

5.2. Summary of the chapters

There are five chapters in this study with each chapter having a particular focus of its own. Nonetheless, the chapters are not disjointed; they are interrelated and as a whole explore feedback practices and perceptions of mathematics teachers to second language learners.

Chapter 1 contextualised the study. In South Africa's education system, assessment practices have shifted from summative examinations to continuous, formative approaches focused on feedback and improvement. However, implementing formative assessment effectively can be challenging due to time constraints, differentiation, and data interpretation. Black and Wiliam (1998) see formative assessment as an "assessment for learning," guiding instruction and providing actionable feedback. This study explored how grade 4 mathematics teachers in a well-resourced private school understood and enacted assessment, particularly formative assessment. Despite assumptions of progressive practices in such schools, limited research existed on their actual implementation. The study thus sought to understand how these teachers conceptualise assessment and how their understanding translates into classroom practices. By examining their knowledge, beliefs, and observed behaviours, the research sought to contribute to a deeper understanding of assessment practices in private schools, specifically focusing on mathematics. This can inform professional development, policy, and teacher training efforts in South Africa.

The study utilised an interpretivist paradigm and a qualitative case study design, with data collection through semi-structured interviews and classroom observations. Grounded analysis informed by Black and Wiliam's (2009) theory was used to analyse the data. This research holds significance for understanding assessment realities in private schools, informing policy and training, and promoting effective assessment practices for improved learner outcomes. Chapter 1 also outlined the research objectives and key research questions, and gave a brief discussion of the study context, theoretical framework, research design and methodology that was utilised in this study. The chapter concluded with an outline of the chapters.

Chapter 2 focused on the literature review and theoretical framework. The literature review focused on teachers' knowledge and beliefs about formative assessment in mathematics pedagogy. It discussed various assessment methods, including informal assessments embedded in daily teaching activities, diagnostic assessments to identify learning barriers, and baseline assessments to gauge initial understanding. The chapter emphasises the importance of both formal and informal assessments in providing comprehensive insights to enhance teaching and learning. Additionally, it explored South African National Assessment Policies, highlighting the shift towards continuous assessment and formative models post-apartheid. The principles of formative assessment are detailed, emphasising the ongoing process of gathering evidence to provide feedback for improving learning. The impact of formative assessment on learning is discussed, emphasising its role in providing real-time insights into student progress, enabling differentiated instruction tailored to individual needs, and fostering meaningful interactions between teachers and students.

Chapter 2 also discussed the theoretical framework employed in this study. The theoretical framework used in this study focused on Black and Wiliam's (2009) theory of formative assessment. This framework emphasised assessment for learning, highlighting the integral role of assessment in pedagogy rather than just evaluation after pedagogy. It consisted of five key teacher practices: clarifying learning intentions, eliciting evidence of learning, providing feedback, and activating self and peer assessment. Black and Wiliam's (2009) theory which was developed through a meta-analysis of over 250 research studies, underscored the importance of frequent, interactive formative assessment in enhancing student achievement. The framework aligns with Ramaprasad's (1983) three key processes in learning and teaching and involves different agents (teacher, peer, and learner) to structure formative assessment strategies. These strategies include clarifying learning intentions and success criteria, engineering effective classroom discussions and tasks, providing feedback that moves learners

forward, activating students as instructional resources for one another, and activating students as the owners of their learning. This comprehensive framework provides a lens to understand teachers' understanding and enactment of formative assessment in mathematics pedagogy, offering a research-based foundation for analysing classroom practices and identifying areas for professional development.

Chapter 3 delved into the research methodology, providing a detailed overview of the research design and methodology employed. It began by discussing the research paradigm, sampling method, and data analysis techniques used in the study. The chapter highlighted the combination of convenience and purposive sampling strategies to efficiently gather rich data from participants committed to improving assessment practices in the foundation phase of the teaching of mathematics. The convenience sampling approach facilitated effective data collection within time and resource constraints, enabling an exploration of teachers' perceptions and assessment practices meaningfully. The chapter also touched on the importance of transparency in qualitative research, emphasising the need for clear and systematic data analysis processes. Additionally, it outlined how the chosen theoretical framework, Black and Wiliam's (2009) theory of formative assessment, guided the analysis of participants' conceptions and use of formative assessment in mathematics pedagogy. This chapter served as a crucial foundation for understanding how the study was conducted, providing insights into the methodological decisions made to investigate grade 4 mathematics teachers' understandings and enactment of formative assessment.

Chapter 4 discussed the findings. The study revealed a significant disconnect between teachers' conceptual understanding of formative assessment and their actual implementation practices during mathematics instruction. Although all three teachers demonstrated a robust theoretical grasp of formative assessment principles and could articulate its benefits for guiding teaching, adapting strategies, and providing targeted feedback, observational data exposed considerable shortcomings in translating this knowledge into consistent, high-quality classroom application.

Despite recognising formative assessment's value in probing learner understanding and pinpointing misconceptions, teachers heavily relied on summative assessments like quizzes and test reviews rather than purposefully embedding formative techniques throughout lessons. Even when presented with prime opportunities to gather insights during independent practice, teachers frequently missed chances to delve into students' thinking processes and reasoning through questioning. Instead, feedback was predominantly evaluative, focused on judging

accuracy rather than unearthing and addressing underlying conceptual gaps. Furthermore, classroom observations highlighted the teachers' tendencies to over-rely on visual monitoring and personal inferences about student progress rather than directly eliciting verbal explanations that could unpack learners' problem-solving approaches. While observing work samples offered a partial window, maximising formative assessment's potential hinged on creating deliberate spaces for students themselves to articulate their comprehension journeys, roadblocks, and self-evaluations.

Additionally, though teachers voiced understanding of supplying descriptive feedback to clarify learning trajectories, observations captured narrow commentary lacking the precise, elaborative details needed to reinforce aligned work or enhance partial understandings in relation to standards. Overall, the data signalled teachers struggling to seamlessly integrate formative assessment's core tenets despite conceptual endorsements, underscoring the need for continued professional development to bridge this theory-practice divide and truly responsively tailor instruction.

Finally, ***chapter 5*** discusses the findings with reference to the theoretical framework and in relation to the literature discussed in Chapter 2. In addition, the chapter outlines the summary and addresses some limitations of this study. The chapter concludes with suggestions for future research.

5.3 Discussion of findings

In this section, the findings of the study are discussed in relation to existing literature.

RQ1: ***What are grade 4 teachers' understanding of assessment as it relates to the mathematics learning area?***

5.3.1 Theme 1: Practical applications and real-world connections

This theme reflected the teachers' emphasis on the practical nature of mathematics and the importance of connecting mathematical concepts to real-world contexts. Two subthemes emerged.

5.3.1.1 Subtheme 1.1: Hands-on learning experiences

The teachers' emphasis on the importance of hands-on, interactive learning experiences aligns with the principles of constructivism and student-centred learning approaches in mathematics education (Cobb, 1994; Piaget, 1964). By engaging learners in the physical manipulation of materials, real-world examples, and collaborative problem-solving scenarios, teachers create

opportunities for students to actively construct their own understanding of mathematical concepts rather than passively receiving information (Hiebert & Grouws, 2007; Yackel et al., 2000). This approach is consistent with Black and Wiliam's (2009) framework for formative assessment, which emphasises the importance of eliciting evidence of student learning through active engagement and purposeful questioning. The teachers' use of manipulatives, models, and real-world examples serves as a means to make students' thinking visible, allowing teachers to gather insights into their conceptual understanding, preconceptions, and areas of struggle (Cauley & McMillan, 2010; Wiliam, 2011).

By embedding formative assessment practices within these hands-on learning experiences, teachers can continuously monitor student progress, identify misconceptions, and adapt their instruction accordingly. As Teacher A stated, the use of place value blocks and learners' creation of their own addition and subtraction scenarios provided valuable insights into their conceptual grasp of place value and the underlying reasoning behind borrowing and carrying procedures. This aligns with Black and Wiliam's (2009) emphasis on using formative assessment data to inform and refine pedagogical strategies, ultimately improving student understanding.

The constructivist approach exemplified by Teacher B, where learners were encouraged to explore and discover the properties of 2D shapes through hands-on activities and guided questioning, is supported by research on effective mathematics instruction (Cobb et al., 1992; Stein et al., 2008). By allowing learners to actively construct their own understanding through exploration and enquiry rather than being presented with abstract definitions and procedures, teachers foster deeper conceptual understanding and promote mathematical reasoning skills (Hiebert & Grouws, 2007; Kilpatrick et al., 2001). Teacher C's use of real-life examples and collaborative problem-solving scenarios further exemplifies the importance of situating mathematics learning within authentic contexts (Boaler, 2002; Lesh & Zawojewski, 2007). By having learners work through practical problems, such as representing a real-world scenario using algebraic equations, teachers not only increase engagement and comprehension but also promote the development of mathematical modelling and problem-solving skills (Lesh & Doerr, 2003; Zawojewski et al., 2003).

The teachers' emphasis on formative assessment within these hands-on learning experiences aligns with Black and Wiliam's (2009) framework, which emphasises the importance of activating students as instructional resources for one another and fostering self-regulated

learning. Through collaborative problem-solving activities and guided questioning, students have opportunities to articulate their thinking, receive feedback from peers and teachers, and engage in self-assessment and reflection (Cauley & McMillan, 2010; Wiliam, 2011).

5.3.1.2 Subtheme 1.2: Developing practical value and skills

The findings from the teachers' quotes resonate with the theoretical framework proposed by Black and Wiliam (1998) on the role of formative assessment in promoting deep learning and understanding. The teachers' perspectives highlight the importance of assessing practical value and skills through formative assessment, aligning with Black and Wiliam's (2009) emphasis on developing higher-order thinking skills and meaningful application of knowledge. One of the key aspects highlighted in the findings is the teachers' desire to move away from assessments focused solely on procedural knowledge or content mastery. Instead, they aim to design assessments that evaluate learners' ability to apply mathematical concepts to real-world situations, engage in critical thinking, and problem-solving, and effectively communicate their mathematical reasoning. This approach is supported by Black and Wiliam's (2009) assertion that formative assessment should elicit evidence of learners' understanding rather than mere reproduction of knowledge.

The teachers describe using "practical problems or case studies," "scenarios," and "multi-step problems" that require learners to integrate and apply various mathematical concepts, justify their reasoning, and communicate their thought processes clearly. These authentic tasks and open-ended questions align with Black and Wiliam's (2009) advocacy for formative assessment tasks that promote higher-order thinking skills and meaningful learning. Furthermore, the findings suggest that the teachers view formative assessment as a means to gather insights into the learners' practical skill development, enabling targeted reteaching and scaffolded practice. This resonates with Black and Wiliam's (2009) emphasis on the role of feedback in formative assessment, both for learners to improve their understanding and for teachers to modify their instruction accordingly.

By designing formative assessments that assess learners' ability to transfer their knowledge to authentic, real-world contexts, the teachers are promoting the development of versatile mathematical literacy and evaluative proficiencies. This aligns with Black and Wiliam's (2009) assertion that formative assessment should foster the acquisition of transferable competencies essential for future learning and participation in an information-based society. The literature supports the teachers' approach to formative assessment, highlighting its potential to promote

deep learning and understanding, develop higher-order thinking skills, and facilitate the meaningful application of knowledge to real-world contexts. Black and Wiliam's (1998) work provides a strong theoretical foundation for the teachers' perspectives, emphasising the importance of formative assessment practices that move beyond rote memorisation and procedural fluency to cultivate enduring understandings and analytical habits of mind.

5.3.2 Theme 2: Formative assessment for monitoring and guiding conceptual understanding

This theme focused on the teachers' perceptions of formative assessment as a means to continuously monitor students' learning progress, identify conceptual understandings or misunderstandings, and provide ongoing guidance to support meaningful learning in mathematics. Two sub-themes emerged.

5.3.2.1 Subtheme 2.1: Monitoring the learning process

The teachers' perspectives on using formative assessment to monitor the learning process, identify conceptual understandings or misunderstandings, and provide ongoing guidance aligned with Black and Wiliam's (1998) seminal work emphasising formative assessment's role in promoting deep learning and understanding. Their views reflect a conception of formative assessment as an integral tool for tracking conceptual development, identifying "better ways of understanding," and enabling responsive, learner-centred instruction tailored to emergent needs.

Eliciting evidence of student understanding is central to effective formative assessment practice (Heritage, 2010). The teachers describe using various strategies like questioning, observation, and analysing learner work to gather continuous feedback on how students grasp concepts, their misconceptions, and prior knowledge. This aligns with Black and Wiliam's (2009) emphasis that formative assessment should reveal learners' thinking rather than just checking recall. The findings show that teachers value formative assessment data to make instructional adjustments and provide targeted support, echoing Black and Wiliam's (2009) view of its role in shaping pedagogical decisions. As Shepard (2005) notes, formative assessment provides a "feedback loop" where evidence informs subsequent teaching to address gaps and facilitate meaningful learning.

The teachers recognise that learners bring diverse prior knowledge, reflecting the need for formative assessment to uncover preconceptions as outlined by Ausubel's (1968) theory on the role of prior knowledge in learning. Teacher C highlights modifying instruction based on

students' unique understandings, aligning with Black and Wiliam's (2009) assertion that formative assessment should account for existing knowledge. Using formative assessment to reteach concepts from different angles and provide personalised guidance, as described, exemplifies its potential for "instructional contingency" noted by Shavelson et al. (2008) - responsively adapting teaching based on assessment evidence. The literature reinforces the value teachers place on formative assessment for monitoring conceptual development and shaping pedagogical responses. As Wiliam (2011) states, its true power lies in the insights it provides to support student success through responsive teaching tailored to individual needs.

Overall, these findings reflect a conception of formative assessment enabling "learner-centred, growth-oriented teaching" (Moss & Brookhart, 2009) refined responsively based on ongoing assessment of emerging needs. This aligns with Black and Wiliam's (2009) vision of formative assessment as integral to fostering deep understanding through continuous evidence-based pedagogical calibration.

5.3.2.2 Subtheme 2.2: Adapting teaching and providing effective guidance

The teachers' perspectives on using formative assessment to adapt their teaching and provide effective guidance align with the theoretical framework proposed by Black and Wiliam (1998). Their views reflect an understanding of formative assessment as a means to gather insights into learners' strengths, weaknesses, and misconceptions, enabling responsive and personalised instruction tailored to individual needs.

A key aspect highlighted by the teachers is the ability to use formative assessment data to identify areas of struggle or misconceptions and subsequently adjust their instructional approaches. This resonates with Black and Wiliam's (2009) emphasis on using formative assessment evidence to inform teaching decisions and adapt instruction to better support learning progress. As Teacher A mentioned, formative assessment provides the "flexibility to adjust the approach" by reteaching concepts using different strategies, examples, or representations that better resonate with learners' understanding.

This notion of adapting instruction based on assessment evidence aligns with the concept of "instructional contingency" as described by Shavelson et al. (2008). By continuously gathering feedback on learners' understanding, teachers can make contingent adjustments to their teaching methods, materials, or explanations in response to the identified needs and misconceptions of their students.

The teachers also recognised the value of formative assessment in identifying learners' strengths and areas of excellence, enabling them to provide more targeted guidance and support where needed. As Teacher B highlighted, this holistic understanding of learners' profiles allows teachers to "meet each learner where they are" and guide them towards deeper comprehension in a tailored and effective manner. This approach resonates with Black and Wiliam's (2009) emphasis on using formative assessment to tailor instruction to individual learners' needs and facilitate their conceptual growth. By identifying areas of strength and weakness, teachers can provide specific feedback, reteaching, or enrichment opportunities that support each learner's unique learning trajectory.

Teacher C's perspective on using formative assessment to "gather insights into specific misconceptions or areas of confusion" and subsequently "address those issues directly" through targeted feedback or reteaching aligns with Black and Wiliam's (2009) vision of formative assessment as a means to overcome misunderstandings and support meaningful learning. Additionally, Teacher C's recognition of the importance of identifying effective strategies for different learners and "capitalising on those strengths to facilitate their conceptual growth" reflects an understanding of the need to leverage learners' diverse strengths and approaches as resources for deeper learning, a principle supported by various educational theorists such as Vygotsky's Zone of Proximal Development).

Overall, the teachers' quotes convey a conception of formative assessment as an essential tool for shaping responsive, differentiated, and student-centred pedagogy. By continuously gathering insights into learners' conceptual development, misconceptions, and strengths, teachers can refine their instruction to address specific needs and leverage the unique growth opportunities of individual learners or groups. This aligns with Black and Wiliam's (2009) vision of formative assessment as a means to promote deep learning and understanding by fostering a learner-centred, growth-oriented approach to teaching. As Moss and Brookhart (2009) assert, formative assessment's true power lies in its capacity to catalyse teaching practices that are tailored to individual learners' needs and focused on supporting their ongoing conceptual development.

5.3.3 Theme 3: Challenges in implementation

The findings also revealed challenges that teachers face in implementing formative assessment effectively, such as time constraints, managing differentiation, and interpreting assessment data. These challenges are well-documented in the literature (Yin et al., 2008; Box et al., 2015;

Heritage, 2007; Shavelson et al., 2008). Time constraints and managing differentiation are significant hurdles, as formative assessment requires frequent, ongoing assessment and tailored feedback for diverse learners (Heritage, 2007; Popham, 2008). Interpreting assessment data can also be challenging, as teachers must analyse student responses, identify misconceptions, and adjust instruction accordingly (Shavelson et al., 2008; Black & Wiliam, 1998).

However, Black and Wiliam (1998) emphasised that formative assessment practices should be integrated seamlessly into the instructional process, suggesting the need for ongoing professional development, collaborative planning, and strategic use of resources to address these challenges. Professional development can equip teachers with the knowledge and skills to effectively implement formative assessment strategies (Wylie & Lyon, 2015; Popham, 2011). Collaborative planning can facilitate the sharing of best practices, the development of high-quality assessments, and the efficient use of instructional time (Moss & Brookhart, 2019; Heritage, 2007). Additionally, strategic use of resources, such as technology-enhanced assessments and data management systems, can streamline the assessment process and support data-driven decision-making (Pellegrino & Quellmalz, 2010; Stiggins & Chappuis, 2005).

5.4 RQ2: How does grade 4 teachers' understanding of assessment influence their practice of classroom assessment as it relates to the mathematics learning area?

While the teachers demonstrated a relatively strong conceptual understanding of formative assessment principles during the interviews, the observational data revealed some significant gaps in consistently translating that knowledge into effective classroom practice.

5.4.1 Theme 1: Strong conceptual understanding, inconsistent practice

The theory-practice gap observed in this study, where teachers demonstrate a strong conceptual grasp of formative assessment but struggle to consistently implement it in their classrooms, is a well-documented phenomenon in the literature (Heitink et al., 2016; Wylie & Lyon, 2015). Several factors contribute to this disconnect, offering insights into the challenges faced by educators in translating their knowledge into skilful practice.

One significant barrier is the lack of sustained professional development opportunities tailored to formative assessment (Buck & Troman, 2009; Stiggins, 2005). Effective implementation of formative assessment requires ongoing training, mentoring, and collaborative learning opportunities for teachers to develop and refine their skills. Without adequate support and guidance, teachers may struggle to bridge the gap between their theoretical understanding and

their ability to seamlessly integrate formative assessment practices into their instructional routines.

Time constraints and the pressures of an already demanding workload can also hinder teachers' ability to consistently implement formative assessment (Buck & Troman, 2009). Effective formative assessment requires frequent check-ins, continuous monitoring of student progress, and the provision of timely and meaningful feedback. However, teachers often face time constraints due to administrative responsibilities, and the need to cover an extensive curriculum, which can make it challenging to prioritise and consistently implement formative assessment strategies. Additionally, the ingrained cultural norms surrounding traditional assessment practices can pose a significant barrier to the integration of formative assessment (Stiggins, 2005). Many teachers have been trained and socialised in an educational system that emphasises summative assessments and high-stakes testing, which can make it difficult to shift their mindset and pedagogical approach towards a more formative, student-centred model of assessment.

Black and Wiliam's (2009) theory of formative assessment emphasises the importance of eliciting evidence of student learning as a critical component of the process. The observed inconsistencies in teachers' practices, such as missed opportunities for probing learner thinking and understanding, highlight the need for more focused training and support in this aspect of the framework. Teachers may require guidance in developing effective questioning techniques, creating opportunities for student discourse, and analysing student responses to gain insights into their learning needs. To bridge this theory-practice gap, sustained professional development initiatives that combine conceptual knowledge with practical strategies and opportunities for ongoing coaching and collaboration are essential (Cauley & McMillan, 2010). These initiatives should aim not only to deepen teachers' theoretical understanding but also provide them with the necessary skills and support to effectively integrate formative assessment into their daily pedagogy. By aligning professional development initiatives and classroom support systems with Black and Wiliam's (2009) framework, teachers can be better equipped to bridge the theory-practice gap. Focused training on strategies for eliciting evidence of student learning, providing descriptive feedback, and activating self and peer assessment can empower teachers to seamlessly integrate formative assessment into their daily instructional routines.

Furthermore, addressing the cultural and systemic barriers that reinforce traditional assessment practices is crucial. This may involve promoting a shift in mindset towards a more student-centred and growth-oriented approach to assessment, as well as aligning curriculum and assessment policies to support the implementation of formative assessment practices (Stiggins, 2005). By addressing these factors and providing comprehensive support, teachers can be better equipped to overcome the challenges that contribute to the theory-practice gap, enabling them to consistently translate their conceptual understanding of formative assessment into effective classroom practices that enhance student learning.

5.4.2 Theme 2: Assessment for learning vs. assessment of learning

The conflation between formative assessment (assessment for learning) and summative assessment (assessment of learning) observed in the study is a persistent challenge in educational settings, as noted in the literature (Stiggins, 2002; Torrance & Pryor, 1998). This blurring of lines between the two distinct purposes of assessment can lead teachers to inadvertently prioritise summative practices, which focus on evaluating learning outcomes, over formative practices that are designed to support and enhance the learning process itself.

Black and Wiliam's (2009) theory of formative assessment explicitly emphasises the importance of using assessment as a means to inform and adapt pedagogy rather than solely for evaluative purposes. The observed practices, such as reviewing past test questions without actively probing current understanding or relying heavily on test preparation, run counter to the core principles of formative assessment as a continuous, embedded process within teaching and learning.

This disconnect between theory and practice can be attributed, in part, to the deeply ingrained cultural norms and traditions surrounding assessment in educational systems. Historically, assessment has often been viewed primarily as a tool for measuring and grading student achievement, with a strong emphasis on summative assessments and high-stakes testing (Stiggins, 2005). This traditional perspective can make it challenging for teachers to shift their mindset and practices towards a more formative, learner-centred approach to assessment.

To address this issue, professional development initiatives play a crucial role in clearly delineating the distinctions between formative and summative assessment and providing guidance on effectively integrating formative assessment practices into daily classroom routines (Popham, 2008; Stiggins, 2005). These initiatives should aim to foster a deeper

understanding of the fundamental differences between the two purposes of assessment, as well as the unique roles they play in supporting student learning.

Formative assessment, as conceptualised by Black and Wiliam (2009), is an integral part of the instructional process, designed to gather evidence of student learning, provide feedback that moves learning forward, and inform ongoing adjustments to teaching strategies and learning activities. In contrast, summative assessment is primarily focused on evaluating and documenting learner achievement at a particular point in time, often for grading, accountability, or decision-making (Cauley & McMillan, 2010; Popham, 2008). By clearly distinguishing between these two purposes, professional development can help teachers understand the complementary roles that formative and summative assessment play in supporting student learning. While summative assessments provide a snapshot of cumulative learning, formative assessment is an integral part of the ongoing instructional cycle, allowing teachers to continuously monitor and respond to learner needs, adjust their teaching strategies, and provide targeted support to address identified gaps or misconceptions.

Furthermore, professional development initiatives should provide practical strategies and examples for effectively integrating formative assessment practices into daily classroom routines. This may include techniques for eliciting evidence of student learning through questioning, observation, and analysis of learner work, as well as strategies for providing descriptive feedback and activating self and peer assessment (Black & Wiliam, 2009; Cauley & McMillan, 2010). By clearly distinguishing between the purposes of formative and summative assessment and providing teachers with the knowledge and skills to effectively integrate formative assessment practices into their pedagogical routines, professional development can help bridge the gap between theory and practice, ensuring that assessment is truly utilised as a tool for learning rather than solely for evaluation.

5.4.3 Theme 3: Over-reliance on teacher observation versus learner articulation

The over-reliance on teacher observation and inference, rather than actively eliciting learner articulation of their thinking and problem-solving approaches, is a well-documented challenge in the effective implementation of formative assessment (Heritage, 2010; Wylie & Lyon, 2015). This finding highlights a crucial aspect of Black and Wiliam's (2009) framework for formative assessment, which emphasises the importance of eliciting evidence of student learning as a critical component of the process.

Black and Wiliam's (2009) theory recognises that merely observing learners' work or responses is insufficient for gaining a comprehensive understanding of their learning needs, misconceptions, and areas of struggle. Instead, teachers must create opportunities for students to actively articulate their thought processes, reasoning, and problem-solving approaches through purposeful questioning and discourse (Cauley & McMillan, 2010; Ruiz-Primo & Furtak, 2007). Effective formative assessment requires a shift from a teacher-centred approach, where the teacher is the primary source of knowledge and evaluation, to a more learner-centred approach that empowers learners to actively participate in the assessment process (Black & Wiliam, 2009). By eliciting student articulation, teachers can gain deeper insights into the nuances of their understanding, the origins of their misconceptions, and the specific areas where additional support or scaffolding is needed.

Research has shown that when learners are given opportunities to verbalise their thinking, they not only reveal their current level of understanding but also engage in metacognitive processes that can further deepen their learning (Furtak et al., 2008; Wiliam, 2011). By articulating their thought processes, learners are encouraged to reflect on their own reasoning, identify gaps or inconsistencies, and actively construct new knowledge or refine existing understandings. However, eliciting student articulation requires specific strategies and techniques that may not be inherent in traditional teaching practices. Teachers may need professional development and guidance in developing effective questioning techniques, facilitating productive classroom discourse, and creating a learning environment that encourages student voice and active participation (Cauley & McMillan, 2010; Ruiz-Primo & Furtak, 2007).

Additionally, it is important to recognise that learner articulation should not be limited to verbal communication alone. Formative assessment can also leverage various modes of expression, such as written reflections, visual representations, or technological tools, to provide learners with multiple avenues to demonstrate their understanding and thought processes (Heritage, 2010; Wiliam, 2011).

By emphasising the importance of eliciting student articulation and providing teachers with the necessary support and strategies, professional development initiatives can better align with Black and Wiliam's (2009) framework for formative assessment. This shift from a reliance on teacher observation to actively engaging students in articulating their thinking cannot only enhance teachers' ability to gather meaningful evidence of learning but also promote a more

student-centred and responsive instructional approach that fosters deep conceptual understanding and metacognitive skills.

5.4.4 Theme 4: Good understanding of descriptive feedback but missed opportunities.

The disconnect between teachers' theoretical understanding of the importance of descriptive feedback and their limited implementation of it in practice is a phenomenon that aligns with previous research findings (Gamlem & Munthe, 2014; Sadler, 1989). This discrepancy highlights a critical aspect of Black and Wiliam's (2009) formative assessment framework, which emphasises the significance of providing feedback that moves learners forward rather than merely evaluative comments.

According to Black and Wiliam's (2009) theory, descriptive feedback plays a crucial role in effective formative assessment by highlighting learners' current level of understanding and providing guidance for further learning. This type of feedback is distinct from evaluative comments that merely judge the correctness or incorrectness of a response, as it focuses on identifying strengths, areas for improvement, and specific strategies or steps that can advance the learner's progress (Hattie & Timperley, 2007; Shute, 2008).

The observed missed opportunities for providing descriptive feedback in this study may stem from various factors that have been documented in the literature. Time constraints and large class sizes are often cited as barriers to providing individualised, detailed feedback (Buck & Troman, 2009; Wylie & Lyon, 2015). Teachers may find it challenging to allocate sufficient time to analyse each student's work, identify specific areas of strength and weakness, and craft feedback that addresses their unique learning needs.

Additionally, a lack of specific training in providing effective feedback can contribute to the observed discrepancy (Cauley & McMillan, 2010; Sadler, 1989). While teachers may understand the importance of descriptive feedback in theory, translating that understanding into practice requires specific strategies and techniques. Without adequate professional development and guidance, teachers may struggle to develop the skills necessary to provide feedback that is targeted, actionable, and aligned with learning goals.

Furthermore, research has shown that effective descriptive feedback should be tailored to individual student needs and aligned with specific learning objectives (Cauley & McMillan, 2010; Sadler, 1989). This requires teachers to have a deep understanding of the learning progression, the ability to diagnose student misconceptions or gaps, and the capacity to provide

feedback that addresses those specific areas while also promoting self-regulation and metacognitive skills.

To address these challenges and better align with Black and Wiliam's (2009) formative assessment framework, professional development initiatives should focus on equipping teachers with practical strategies for providing descriptive feedback. This may include training on effective questioning techniques to uncover student understanding, developing rubrics or success criteria that clearly articulate learning goals and providing examples of high-quality descriptive feedback that can serve as models for teachers.

Additionally, professional development should emphasise the importance of creating a classroom culture that values feedback as a means of supporting learning rather than merely evaluating performance. By fostering a growth mindset and promoting a safe, supportive environment for risk-taking and learning from mistakes, teachers can create an atmosphere where descriptive feedback is embraced as a valuable tool for advancing understanding (Dweck, 2006; Wiliam, 2011).

By addressing the barriers and providing targeted support in providing descriptive feedback, professional development initiatives can better align with Black and Wiliam's (2009) formative assessment framework. This, in turn, can empower teachers to leverage the power of feedback as a means of moving learners forward, fostering self-regulation, and ultimately enhancing student achievement and conceptual understanding.

5.5. Limitations of the study

This study provides valuable insights into grade 4 teachers' understanding and implementation of formative assessment practices in mathematics at a private school in South Africa. However, it is essential to acknowledge the limitations when interpreting the findings and implications.

5.5.1 Snapshot in time

The data collection for this study occurred during a specific term (Term 2) and captured teachers' formative assessment practices at a single point in time. However, it is important to recognise that teachers' understandings, beliefs, and practices regarding formative assessment may evolve, influenced by various factors such as professional development, experience, and changes in curriculum or school policies. This study's snapshot approach may not fully capture the dynamic nature of the teachers' formative assessment practices and the potential changes that could occur over an extended period.

5.5.2 Single School context

This research was conducted within the context of a private school in South Africa, and the findings reflect the experiences and practices of a specific group of grade 4 mathematics teachers. While the insights gained are valuable, it is essential to exercise caution when attempting to generalise the results to other educational settings or contexts. Different schools, whether private or public, may have unique factors, such as school culture, resources, and student demographics, that could influence teachers' formative assessment practices and the challenges they encounter.

5.5.3 Lack of student perspectives

The study focused primarily on teachers' understanding and practices of formative assessment, relying on interviews and classroom observations as the primary data sources. While these methods provided valuable insights into teachers' perspectives and actions, the study did not directly incorporate student perspectives or explore the impact of formative assessment practices on student learning outcomes. Including student voices and experiences could have enriched the findings and provided a more comprehensive understanding of the role and effectiveness of formative assessment in the mathematics classroom.

5.6. Recommendations

From the findings and analysis of this study and the literature reviewed on teachers' perceptions and practices of formative assessment feedback, I find the following recommendations pertinent.

5.6.1 Ongoing professional development

The findings highlight the need for ongoing, sustained professional development opportunities focused specifically on formative assessment strategies in mathematics teaching. While the teachers demonstrated a conceptual understanding of formative assessment, translating this knowledge into consistent, high-quality implementation proved challenging. Professional development initiatives should provide teachers with concrete strategies, modelling, and hands-on practice in effectively integrating formative assessment techniques throughout their mathematics lessons. Particular emphasis should be placed on developing skills in questioning, eliciting student thinking, interpreting assessment data, and providing descriptive feedback aligned with learning progressions and standards. This aligns with the literature, which emphasises the importance of sustained, content-specific professional development in enhancing teachers' formative assessment practices (Wiliam, 2011; Heritage, 2010).

5.6.2 Collaborative planning and learning communities

Establishing collaborative planning time and professional learning communities can support teachers in overcoming the challenges associated with formative assessment implementation. Through collaborative efforts, teachers can share best practices, co-plan formative assessment strategies, and collectively analyse student work and assessment data. This collaborative approach can alleviate time constraints and provide a supportive environment for continuous learning and refinement of formative assessment practices. Additionally, learning communities can foster accountability and encourage sustained implementation efforts. Research has demonstrated the positive impact of teacher collaboration and learning communities on the effective implementation of formative assessment practices (Wylie & Wiliam, 2007; Moss & Brookhart, 2019).

5.6.3 Using technology and resources

The study also suggests the need to explore and leverage technology and resources that can support formative assessment practices. Digital tools and platforms can streamline the collection, organisation, and analysis of formative assessment data, potentially alleviating some of the time constraints faced by teachers. Furthermore, access to high-quality formative assessment resources, such as task banks, exemplars, and rubrics, can enhance teachers' ability to design effective formative assessment opportunities and provide precise, descriptive feedback aligned with curriculum standards. This recommendation aligns with research highlighting the potential of technology and resources to support formative assessment practices (Pellegrino & Quellmalz, 2010; Phelan et al., 2019).

5.6.4 Ongoing Training and Feedback Cycles

To bridge the gap between theory and practice, ongoing training and feedback cycles focused on formative assessment implementation may prove beneficial. On-site pedagogical trainers or peer observation cycles can provide teachers with individualised support, modelling, and feedback as they work to integrate formative assessment strategies into their mathematics instruction. These feedback cycles can help teachers identify areas for improvement, celebrate successes, and continuously refine their formative assessment practices in a supportive and collaborative manner. This recommendation is supported by the literature emphasising the importance of ongoing, job-embedded professional development and coaching in promoting sustained changes in instructional practices (Desimone & Garet, 2015; Kang et al., 2019).

By addressing these recommendations through a comprehensive and sustained approach, schools and districts can support teachers in overcoming the challenges identified in the study and fostering a culture of effective formative assessment practices in mathematics classrooms. Ultimately, such efforts can enhance student learning, engagement, and achievement by ensuring that instruction is continuously informed by and responsive to students' emerging understanding and needs.

5.7 Recommendations for future research

The following are recommendations for any future study:

5.7.1 Longitudinal studies

This study provided a snapshot of teachers' understanding and practices of formative assessment in mathematics at a particular point in time. Future research could take a longitudinal approach, following a cohort of teachers over an extended period as they receive professional development and support in implementing formative assessment strategies. Longitudinal studies could track the evolution of teachers' formative assessment practices, document the challenges they encounter at different stages, and identify the most effective professional development approaches and support mechanisms for sustained implementation.

5.7.2 Impact on student learning and achievement

While this study focused on teachers' understanding and practices of formative assessment, future research could investigate the impact of effective formative assessment implementation on student learning outcomes and achievement in mathematics. Such studies could explore the relationship between specific formative assessment strategies (e.g., questioning techniques, and feedback practices) and students' conceptual understanding, problem-solving abilities, and overall mathematics performance. This research could provide valuable insights into the potential benefits of formative assessment for enhancing student learning and informing the development of evidence-based practices.

5.7.3 Comparative studies

Researchers could conduct comparative studies to examine the differences in formative assessment practices across different grade levels, school settings (e.g., public vs. private), or educational contexts. Such studies could explore whether the challenges and strategies for effective implementation vary based on factors like grade level, curriculum standards, or student demographics. Comparative research could also investigate the impact of school

leadership, professional learning communities, and other contextual factors on the successful integration of formative assessment practices.

5.7.4 Teacher beliefs and mindsets

Future research could delve deeper into the relationship between teachers' beliefs, mindsets, and their formative assessment practices. Qualitative studies could explore how teachers' beliefs about teaching, learning, and assessment influence their willingness to adopt formative assessment strategies, as well as their ability to implement them effectively. Understanding the role of teacher beliefs and mindsets could inform targeted professional development approaches and strategies for promoting buy-in and sustained implementation of formative assessment practices.

5.7.5 Technology integration and digital tools

As technology continues to evolve, researchers could investigate the potential of digital tools and platforms to support formative assessment practices in mathematics classrooms. This research could explore the design, implementation, and effectiveness of technology-enhanced formative assessment strategies, such as digital formative assessment tasks, interactive feedback systems, and data analytics tools. Such studies could provide valuable insights into how technology can be leveraged to streamline formative assessment processes, enhance data collection and analysis, and facilitate more personalised and responsive instruction.

By addressing these recommendations for future research, the field can continue to advance our understanding of formative assessment practices in mathematics education, their impact on student learning, and the most effective strategies for supporting teachers in implementing formative assessment practices effectively and sustainably.

5.8 Conclusion

This study investigated grade 4 teachers' understanding and implementation of formative assessment practices in mathematics at a private school in South Africa. The findings revealed valuable insights into the challenges and opportunities surrounding effective formative assessment integration.

While the participant teachers demonstrated a strong conceptual grasp of formative assessment principles during interviews, observational data exposed notable gaps in translating this understanding into consistent, high-quality classroom practices. Teachers tended to rely heavily on summative assessments and often missed opportunities to gather formative insights during instruction through questioning and active monitoring of student thinking processes.

The study highlights the need for ongoing professional development tailored specifically to enhancing teachers' skills in formative assessment techniques within the mathematics learning area. Collaborative planning time, professional learning communities, and access to instructional coaching could provide crucial support in bridging the divide between theory and practice. Furthermore, leveraging technology and high-quality resources may alleviate time constraints and facilitate more efficient data collection, analysis, and feedback processes.

Despite the challenges identified, the findings also showcased instances where teachers successfully implemented formative assessment strategies, such as using hands-on activities, real-world connections, and monitoring conceptual understanding. These pockets of effective practice suggest a foundation upon which to build and reinforce formative assessment as an integral part of mathematics instruction.

In the context of this private school setting, addressing the recommendations outlined in this study could foster a culture of continuous learning and responsiveness to students' emerging needs. By prioritising formative assessment, teachers can ensure that instruction is dynamically tailored to individual and collective areas of growth, ultimately enhancing student engagement, conceptual understanding, and achievement in mathematics.

While this study focused on a specific grade level and school environment, the insights gained underscore the importance of formative assessment as a pedagogical approach that transcends contexts. Future research efforts could further explore the impact of effective formative assessment practices on student learning outcomes, investigate the role of teacher beliefs and mindsets, and delve into the potential of technology integration to support formative assessment processes.

Ultimately, this study catalysed ongoing efforts to improve the quality of mathematics education by empowering teachers with the knowledge, skills, and support necessary to seamlessly integrate formative assessment into their daily instructional practices. By embracing a culture of responsive teaching informed by continuous assessment, educators can foster a learning environment that nurtures mathematical proficiency, problem-solving abilities, and a deep appreciation for the practical value and relevance of mathematics in the lives of students.

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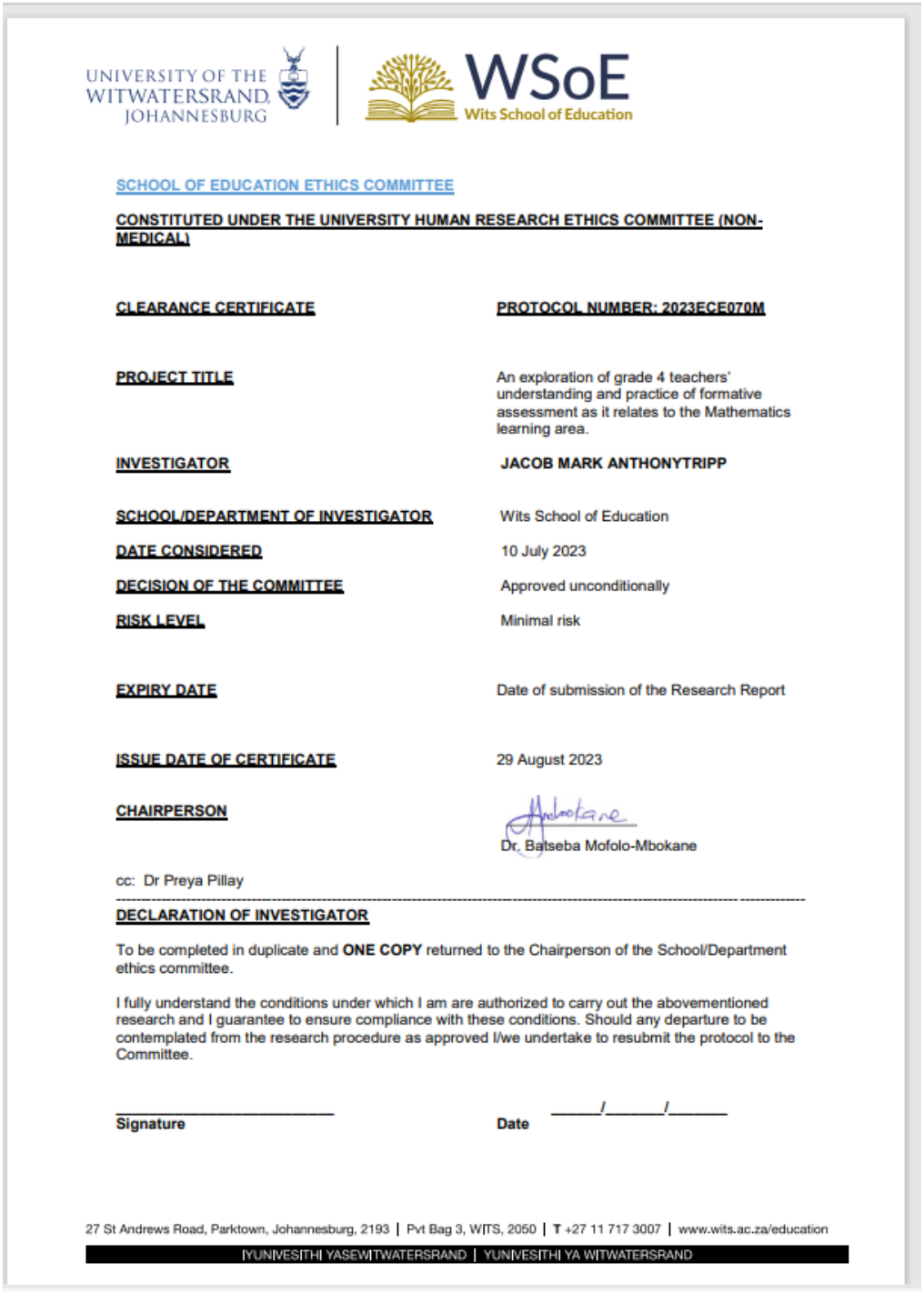
APPENDIX A

ETHICAL CLEARANCE CERTIFICATE



UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | WSoE Wits School of Education

SCHOOL OF EDUCATION ETHICS COMMITTEE

CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: 2023ECE070M**
PROJECT TITLE	An exploration of grade 4 teachers' understanding and practice of formative assessment as it relates to the Mathematics learning area.
INVESTIGATOR	**JACOB MARK ANTHONYTRIPP**
SCHOOL/DEPARTMENT OF INVESTIGATOR	Wits School of Education
DATE CONSIDERED	10 July 2023
DECISION OF THE COMMITTEE	Approved unconditionally
RISK LEVEL	Minimal risk
EXPIRY DATE	Date of submission of the Research Report
ISSUE DATE OF CERTIFICATE	29 August 2023
CHAIRPERSON	Dr. Batseba Mofolo-Mbokane

cc: Dr Preya Pillay

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am are authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

_____ **Signature**

_____/_____/_____ **Date**

27 St Andrews Road, Parktown, Johannesburg, 2193 | Pvt Bag 3, WITS, 2050 | T +27 11 717 3007 | www.wits.ac.za/education

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APPENDIX B

LETTER TO THE PRINCIPAL

INFORMATION SHEET: LETTER TO THE PRINCIPAL

Dear Mr. Gerassi

My name is Jacob Tripp in the School of Education at the University of the Witwatersrand.

I am doing research on: exploring grade 4 teachers' understanding of assessment and how their understandings influence their praxis in the subject area of Mathematics. My objective is to understand how teachers' understanding of assessment shapes the way they make use of it in their classrooms.

My research involves interviewing three of your teachers for 45 minutes about their understandings of formative assessment as a Mathematics teacher in Grade 4 and classroom and classroom observation of three lessons each for the three teachers. These observations can potentially provide in-depth information as to how assessments are designed and implemented. This study is informed by the paucity of research on formative assessment understandings and practices in the subject area of Mathematics. Historically, assessment has been used as a tool to measure and grade, only recently has assessment been conceptualized as a tool that can enhance and inform learning. Consequently, greater insight is required on how teachers come to understand the uses of assessment and how their understandings influence their praxis in the subject area of mathematics. Moreover, this research will help me advance my knowledge and understanding of assessment practices in primary schools.

The reason why I have chosen your school is because it is within the geographical location (In and around Johannesburg CBD) on which this study is intended to be carried out. I am inviting your school to participate in this research study. All interviews will take place between the 1st and 3rd of August, in the afternoons from 15:00 – 16:00.

Ethical Considerations:

Participation in this study is entirely voluntary. Therefore, you can decide to withdraw at any time without any penalty. Participation codes will be used to refer to you. All identifying materials, including videos and other electronic data, will be stored on a Cloud storage platform (Microsoft OneDrive) accessible only to the researcher. The records will be used to generate verbatim transcripts for analysis. Identifying materials will be destroyed when no longer necessary for research.

Are there any risks to participating in this research?

There are minimal risks for professionals in taking part in this study.

Are there any benefits to participating in this research?

There will be no cost for participants for taking part in this study. Participants will not receive any payment for taking part in this study. If you would like to receive a summary of the research, I will be happy to send it to you.

If you have any questions during or afterwards about this research study, feel free to contact me on the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Yours sincerely.

Mr. Jacob Tripp

jacobtripp1411@gmail.com (079 260 4437)

Supervisor: Name and Surname: Dr. Preya Pillay

Email: Preya.pillay@wits.ac.za (011 717 3301)

APPENDIX C

LETTER OF CONSENT: PRINICPAL

LETTER OF CONSENT: PRINICPAL

I_____the school principal at _____grant **Mr Jacob Tripp** permission to conduct research titled: *An exploration of grade 4 teachers' understanding and practice of formative assessment as it relates to the Mathematics learning area.*

Informed consent

I,_____give my consent for the following:

Permission to review/collect documents/artefacts	Cross one	
• I agree that the researcher is allowed to observe three lessons in term 2 for each of the participants	YES	NO
Permission to audiotaped		
• I agree that the researcher can audiotape the interview with one of my teachers for 45 minutes.	YES	NO
• I know that the audiotapes will be used for this project only	YES	NO

Permission to interview		
• I allow the researcher to interview one of my teachers about their feedback perceptions and practices for 45-60 minutes.	YES	NO
• I know that I can stop this permission at any time and the teacher does not have to answer all the questions asked	YES	NO

I also understand that

- The name of the school, participating teacher and principal will remain anonymous.
- In the final report, the researcher will use anonymous quotes.
- All the data collected during this study will be confidentially kept and destroyed within 3-5 years after completion of this project.

Signature:_____ Date:_____

APPENDIX D

INFORMATION SHEET: LETTER TO TEACHER

INFORMATION SHEET: LETTER TO TEACHER

Dear _____

My name is Jacob Tripp in the School of Education at the University of the Witwatersrand.

I am doing research titled: *An exploration of grade 4 teachers' understanding and practice of formative assessment as it relates to the Mathematics learning area.*

My research involves interviewing you for 45 minutes about your perceptions of formative assessment as it relates to the mathematics subject area. In case face-to-face interviews are not possible, we can engage in technology-mediated communication such as Whatsapp voice-calling or Microsoft Teams. I will also be conducting 3 classroom observations in Term 2 on your mathematics lesson; to understand your formative assessment practices. The study aimed to develop a comprehensive understanding of how primary school mathematics teachers conceptualise and implement formative assessment strategies.

The reason why I have chosen your school is because it is within the geographical location (In and around Johannesburg CBD) on which this study is intended to be carried out.

I am inviting you to participate in this research. Your name and identity of the school will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

You will not be advantaged or disadvantaged in any way. You can withdraw your permission at any time during this project without any penalty. There are no foreseeable risks in participating in this study. You will not be paid for this study.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely.

Mr. Jacob Tripp

jacobtripp1411@gmail.com

079 260 4437

Supervisor: Name and Surname: Dr. Preya Pillay

Email: Preya.pillay@wits.ac.za Contact details: 011 717 3301

APPENDIX E

TEACHER'S CONSENT FORM

TEACHER'S CONSENT FORM.

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called:

I,_____give my consent for the following:

Permission to review/collect documents/artefacts	Cross one	
• I agree that the researcher can observe my pedagogical practices and assessment in the teaching of my grade 4 mathematics class over three lessons.	YES	NO
Permission to be audiotaped		
• I agree to be audiotaped during the interview for 45 minutes	YES	NO
• I know that the audiotapes will be used for this project only	YES	NO
Permission to be interviewed		
• I am willing to be interviewed for 45 minutes.	YES	NO
• I know that I can stop this permission at any time and don't have to		
answer all the questions asked	YES	NO
• I understand that if face-to-face interviews are not possible, I might have to use my own data to connect with the researcher.	YES	NO

Informed Consent

I understand that:

- My name and information will be kept confidential and safe and my name and the name of the school will not be revealed.
- I do not have to answers every question and can withdraw from the study at any time.
- I can ask not to be audiotaped, photographed and/or videotaped.
- All the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____ Date_____

APPENDIX F

PERMISSION LETTER: SGB CHAIRPERSONS.

LETTER REQUESTING PERMISSION: SGB CHAIRPERSONS.

Dear Sir/Madam

My name is Jacob Tripp, and I am a Master's student at the Witwatersrand School of Education. I am reaching out to request permission to conduct a research project within your school premises as part of my Master's Degree requirements.

The focus of my research project is to explore Grade 4 teachers' understandings and practices of formative assessment in the subject area of Mathematics. The aim of this study is to develop a comprehensive understanding of how primary school mathematics teachers conceptualize and implement formative assessment strategies. By conducting this research, I hope to contribute valuable insights to the academic literature on formative assessment practices in South African primary schools.

I have chosen your school specifically because it is conveniently located within the Johannesburg CBD, making it easily accessible for me as a researcher. Additionally, I believe that the participation of Grade 4 teachers from your school will provide valuable perspectives for my study.

As part of my research methodology, I plan to observe teachers' lessons and their assessment practices. These observations will provide detailed information on how assessments are designed and implemented, as well as the pedagogical practices associated with the lessons. Furthermore, I will conduct semi-structured interviews with three mathematics teachers in Grade 4 to gain deeper insights into their perspectives and experiences regarding formative assessment.

I assure you that all data collected from the school will be handled with utmost confidentiality and stored securely. Only I will have access to the data, and any analysis of formative assessments will be conducted anonymously using pseudonyms and anonymous quotes to protect the identity of the school, teachers, and learners.

I believe that participation in this research project carries no foreseeable risks or disadvantages for the school or its staff. If granted permission, I kindly request a written permission letter on the school's letterhead, signed, dated, and specifically referring to myself by name and the title of my research study.

Thank you for considering my request. I look forward to your favourable response.

Sincerely,

Researcher: Mr. Jacob Tripp

Contact no: 079 260 4437

Email: jacobtripp1411@gmail.com

Supervisor: Dr Preya Pillay.

Contact no: 011 717 3301

Email: Preya.Pillay@wits.ac.za.

APPENDIX G

CONSENT FORM: SGB CHAIRPERSON

CONSENT FORM: SGB CHAIRPERSON

I _____the School Governing Body Chairperson at_____confirm that permission has been granted to Mr. Jacob Tripp to conduct research titled: *An exploration of grade 4 teachers' understanding and practice of formative assessment as it relates to the Mathematics learning area.*

Informed Consent

Permission to review/collect documents/artefacts	Cross one	
• I agree that the researcher is allowed to observe 3 lessons of the selected participants in the study.	YES	NO
• I understand that the researcher intends to observe the lessons with learners present in the classroom whilst teaching happens.	YES	NO
• I understand that the research will not attract any costs for the school.	YES	NO
Anonymity and Confidentiality.		
• I understand that pseudonyms will be used and the names of the participants will remain anonymous.	YES	NO
• The researcher has made it clear that all data collected for this research will be kept confidential throughout and after the research.	YES	NO
• The researcher has informed me that the data collected will be stored in a password-protected computer and a locked area.	YES	NO

• I know that the researcher will use anonymous quotes in his final report	YES	NO
• I understand that all identifying features of the data collected will be removed in the researcher's final report.	YES	NO
• I know that the teachers, learners and the school may withdraw from this research at any time.	YES	NO

Sign_____ Date_____

APPENDIX H

PERMISSION LETTER: PARENT

LETTER REQUESTING PERMISSION: PARENT.

Dear Parent/Guardian

My name is Jacob Tripp. I am currently doing a Master's degree at the University of the Witwatersrand, in the Cluster of Curriculum Studies, specialising in mathematics education. Your child _____ is invited to participate in a study entitled: *An exploration of grade 4 teachers' understanding and practice of formative assessment as it relates to the Mathematics learning area"*. I am undertaking this study as part of my master`s research study. The aim of the study is to gain insight into teachers' understanding of formative assessment and to explore the extent of alignment between their understandings and practices. This research study will help address empirical gaps, which will elevate understanding of classroom assessment realities in the under-studied private school sector, with wider implications for practice, policy, training, and public perception. It carries significance for educational quality, innovation, and advancement reflective of 21st century global priorities.

This study will focus on classroom teaching of numbers, operations, and relationships for Term 2 with emphasises on strengthening learners' mental mathematics proficiency. I plan to observe lessons on numbers, operations, and relationships. The lessons will not be video-taped but detailed notes of the lesson will be recorded on an observation schedule.

As a parent/guardian I am asking for your permission to allow your child to appear as part of the observation because your child is doing grade 4 at the school which the research is going to be conducted at. I expect to have 19 other children in his/her class participating in the study. Classes will continue as normal, with my presence at the back of the classroom.

All data collected will be used purely for research purposes. All data collected will be archived and securely stored at the University of the Witwatersrand for a duration of five years, after which it will be destroyed. There are no foreseeable risks to your child by participating in the study. Your child will receive no direct benefit from participating in the study. Neither your child nor you will receive any type of payment for participating in this study. Your child's participation in this study is voluntary. You can agree to allow your child to be in the study now and change your mind later without any penalty.

Please note that if permission is not granted, I will respect your decision, and your child will not appear in any of the classroom observations.

Please complete the consent form and return it to the class teacher. If you have any questions or concerns with regards to the study, please free to contact the researcher or supervisor, their details are provided at the end of this letter. Thank you for considering my request. I look forward to your favourable response.

Sincerely,

Researcher: Mr. Jacob Tripp

Contact no: 079 260 4437

Email: jacobtripp1411@gmail.com

Supervisor: Dr Preya Pillay.

Contact no: 011 717 3301

Email: Preya.Pillay@wits.ac.za.

APPENDIX I

CONSENT FORM: PARENT

CONSENT FORM: PARENT

I_____ (please print full name parent/guardian) of_____, (please print full name of learner) have been informed about the study entitled "*An exploration of grade 4 teachers' understanding and practice of formative assessment as it relates to the Mathematics learning area'*" by Mr Jacob Tripp. I understand the purpose and procedures of the study. I have been given an opportunity to ask questions about the study. I have been informed that the participation of my child in this study is entirely voluntary and that I may withdraw his/her participation at any time. I give consent to the following

- My child being present at school, in class during the day of class observation and the researcher observing of mathematics lessons on numbers, operations, and relationships for Term 2 in which my child might appear.

Please tick YES/NO

Regards,

_____

Signature of parent

_____

APPENDIX J

FORMAT OF INTERVIEW

1. Introduction

- Researcher introduces herself, welcomes and thanks the interviewee for availing herself or himself;
- Interviewee introduction and filling in of biographic information;
- Researcher explains the purpose and focus of the interview; and
- Researcher explains the ethical conduct of the interview (confidentiality, respect and anonymity of the interviewee and the school).

2. Questions:

- The researcher poses questions and allows the interviewee to respond; and
- Researcher guides the interviewee when digression occurs.

3. Closure:

- Researcher thanks the interviewee; and
- Researcher requests permission to contact the interviewee to clarify any question that the researcher may have at a time convenient to the interviewee.

APPENDIX K

BIOGRAPHICAL INFORMATION FOR TEACHERS

This form is designed to gather information on teachers' expertise and experience in their current profession which involves the teaching of primary mathematics for grade 4.

Please Tick next to the correct answer

1. What is your position in the school

Foundation phase teacher----------, teacher----------, senior teacher----------

Please Tick next to the correct answer

2. What is your gender?

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

3. What is your age range?

22- 30---------, 31-39----------, 40-49----------, 50-60----------.

4. Experience as a teacher.

0-5 years----------, 5-10 years----------, 11-20 years----------, 21-30 years----------, 31-40 years

Please fill in the blank spaces

5. What is your highest qualification?

---

6. Are you employed as a permanent or temporary teacher?

APPENDIX L

INTERVIEW SCHEDULE FOR GRADE 4 TEACHERS

Topic: *An exploration of grade 4 teachers' understanding and practice of formative assessment as it relates to the mathematics learning area.*

School _____

Teacher's name _____

Time _____

1. Can you describe your overall approach to formative assessment in the mathematics classroom? How do you integrate formative assessment practices into your everyday teaching

2. In what specific ways do you use formative assessment to gather insights into students' conceptual understanding and thought processes in mathematics?

3. How do you use the information gathered from formative assessment to adapt your teaching strategies or provide targeted feedback to students?

4. Can you give an example of a formative assessment task or activity you have used in your classroom that was particularly effective in revealing students' misconceptions or areas of struggle?

5. How do you balance the need to address individual students' needs identified through formative assessment while also ensuring that the entire class is progressing towards the learning goals?

6. In your experience, what are some of the key benefits of using formative assessment in the mathematics classroom?

7. What challenges or barriers have you encountered in effectively implementing formative assessment practices, and how have you addressed them?

8. How do you ensure that your formative assessment practices align with the broader curriculum goals and standards for mathematics learning in your grade level?

9. Can you describe how you involve students in the formative assessment process, and how you communicate feedback or next steps to them based on the assessment data?

10. What professional development opportunities or resources have been most helpful in enhancing your understanding and implementation of formative assessment practices in mathematics instruction?

APPENDIX M

OBSERVATION SCHEDULE

OBSERVATION SHEET

School:	Date:
Class	Time
Teacher Name:	Grade

The table below contains the contents that was observed within the classroom.

<table>
<tr><th>Context</th><th colspan="2">Focal areas for observations</th></tr>
<tr><td>“Physical”</td><td colspan="2">• “Physical appearance of the classroom; the arrangement of desks; availability of chalkboard, notice board, shelves, charts, flashcards, books, worksheets”.
• “Rules employed in the classroom”.</td></tr>
<tr><td>“Personal”</td><td colspan="2">• “The composition in the class, general behaviour, co-operation with the teacher and peers.
• Ways in which the teacher conversed with the learners and how the learners approached the teacher.
• Interpersonal formative activities used to develop mathematics literacy in the students”.</td></tr>
<tr><td rowspan="2">“Interactional”</td><td colspan="2">• “The actual teaching-learning activities, formal and informal interactions between teacher and students, and peers”</td></tr>
<tr><td>“Formative Assessment Techniques”</td><td>• “Observe how teachers integrate formative assessment practices into their regular instructional routines”.</td></tr>
</table>

		• "Look for instances where teachers use techniques such as questioning, observation, discussion, and feedback to gather insights into students' understanding". • "Note the types of formative assessment tasks or activities used (e.g., exit tickets, quizzes, group work, and individual work)".
	"Alignment with Learning Goals"	• "Observe how teachers' formative assessment practices align with the broader curriculum goals and standards for mathematics learning in grade 4". • "Look for instances where teachers assess students' understanding of key mathematical concepts, skills, and processes outlined in the curriculum". • "Note how teachers use formative assessment to monitor and support students' progress towards meeting these learning goals".
	"Differentiation and Personalization"	• "Observe how teachers use formative assessment data to differentiate their instruction and provide personalised guidance to students". • "Look for instances where teachers adapt their teaching strategies or resources based on individual

		students' needs or learning gaps identified through formative assessment". • "Note how teachers balance addressing individual needs while ensuring that the entire class progresses towards the learning goals".
	"Student Engagement and Articulation"	• "Observe how teachers involve students in the formative assessment process". • "Look for instances where teachers encourage students to articulate their thinking processes, problem-solving approaches, and reasoning". • "Note how teachers use student articulation as a formative assessment tool to gain insights into their understanding and address misconceptions".
	"Feedback, Next Steps and Assessment"	• "Observe the types of feedback teachers provide to students based on the formative assessment data". • "Look for instances where teachers provide descriptive feedback that clarifies students' current understanding and provides guidance for future learning". • "Note how teachers communicate feedback and next steps to students,

		and how they involve students in setting goals or planning for their learning based on assessment information".

APPENDIX N

PLAGARISIM REPORT

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by Preya Pillay

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APPENDIX O

EDITORS LETTER

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13 March 2024

An exploration of grade 4 teachers' understanding and practice of formative assessment as it relates to the Mathematics learning area

This confirms that I edited substantively the above document, including a Reference list. The document was returned to the author with various tracked changes to correct errors and clarify meaning. It was the author's responsibility to attend to these changes.

Yours faithfully

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