UNIVERSITY OF JOHANNESBURG

Faculty of Education

Grade 3 teachers' formative assessment practices in selected mathematics lessons

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Thesis submitted in fulfillment of the requirements for the degree of

DOCTORATE IN PHILOSPOHY
in Education
at the
University of Johannesburg

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Date of submission: December 2018

DECLARATION

I, Poomoney Govender, the undersigned, declare that this thesis is in line with the Plagiarism policy of the University of Johannesburg which I am familiar with.

I further declare that the academic work constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions or writings of another.

I declare that the dissertation describes original work that has not previously been presented for the award of any other degree of any institution.

Signature: Govender

Date: December 2018

ACKNOWLEDGEMENT

This research study would not have been possible if it were not for the guidance, support, advice and tutelage offered to me by my most esteemed supervisor, Professor Elizabeth Henning. She persevered and offered me a great deal of her time, extensive personal and professional guidance and most of all she taught me a great deal about scientific research and what it means to conduct empirical research in an ethical manner.

I am also grateful for the financial support provided to me by both the University of Johannesburg under the auspices of a SARCHI Chair of the National Research Foundation (NRF-DST SARChI Chair: *Integrated Studies of Learning Language, Mathematics and Science in the Primary School.* Grant number 98573). My thanks also go to the University of South Africa for support.

Nobody has been more important in pursuit of this doctoral study than my most endeared family, namely my husband, Devan; and my two lovely daughters, Rivonia and Sandrisha. Devan has been a great source of inspiration and has helped me navigate in my academic career. My family has stood by me thick and thin and have bent backwards all the time to accommodate what in some cases were unreasonable demands and requests that I made. Their patience, support and gratuity will always have a special place in my heart.

My sincere gratitude also goes to my extended family members and friends for their assistance and moral support.

My heartfelt thanks goes to Mrs Santha Ponnen who assisted me with the coordination and selection of the participants for this study. I also wish to thank the teachers, Principal's and officials from the Tshwane South District for their support which was vital to the success of this study.

Special thanks to Francois Naude for his assistance with the technical editing and logistics to ensure that I could meet the deadline for the submission of this thesis.

I also extend my heartfelt thanks to Josephine who kept the home running smoothly during the years of my study.

Above all, I am thankful to the Almighty for granting me the health, strength and perseverance to complete this thesis.

A bursary for this study was awarded to me by the NRF-DST SARChi Chair: *Integrated Studies of Learning Language, Mathematics and Science in the Primary School.* Grant number 98573.

DEDICATION

I am honoured to dedicate this thesis to my beloved parents, my mother Sivagami Govender and my late father, Pat Govender. Mum and dad, you have instilled in me the values of love and respect for all beings; inculcated the virtues of hard work and honest labour; encouraged me to have an inquiring mind; and given me the freedom to pursue my own ambitions and develop my unique talents.

“It always seems impossible until it’s done.” - Nelson Mandela

ABSTRACT

This study responds to critical knowledge gaps evident in current literature about how formative assessment is enacted by foundation phase teachers in mathematics in South African public schools. Furthermore, the literature study that I conducted revealed that most of the current research conducted in public primary schools focused on learner performance with emphasis on summative assessment, hence delimiting the importance of formative assessment as a strategic tool in improving learner performance. The aim of this study was to explore how Grade 3 teachers enact formative assessment in mathematics teaching. I therefore investigated teachers' understanding of formative assessment, what teachers know about how children learn mathematics, how teachers use their knowledge of childrens' thinking to plan and enact formative assessment and what support is needed by Grade 3 teachers to enact formative assessment in mathematics classrooms.

Cultural Historical Activity Theory (CHAT) as propounded in third generation activity theory (AT) by Engeström (1987) served as the analytical framework for this study. Third generation AT which focuses on the interaction between a person or group (*subject*), a goal, motivation, or problem (*object*) and mediational interaction with (tools) as well as the intersection with the activity system leading to (outcome/s). This heuristic assisted me to conduct a systemic analysis of all inter-dependencies that had a bearing on how Grade 3 teachers enacted formative assessment and what additional support they required to enact formative assessment in mathematics classrooms.

This study followed a case study research design through a qualitative research approach. I started with a sample of 12 teachers in a selected school district in Tshwane in the Gauteng Province. The teachers were selected through a convenience sampling technique. The data was collected through two focus group interviews from these twelve teachers (divided into six each) as a pilot exploration. I then selected four teachers through purposive sampling. Data was collected through lesson observation, document analysis and four stimulated recall interviews from these four teachers.

The data was analysed through a content analysis technique, utilising Microsoft Macros which assisted me to segment all the data. I thereafter conducted pattern matching of the data. Finally, the data was coded, categorised and thematised.

The core finding demonstrated that, although teachers know about how children learn and that they can align their teaching to how children learn, they struggle to enact formative assessment effectively. Furthermore, while teachers recognise the importance of formative assessment, they do not implement formative assessment skills in an integrated way. The core finding of the study was that teachers' formative assessment practices are constrained by tensions of the activity system.

This study contributes to the body of knowledge of formative assessment by highlighting relevant discords around challenges and successes pertaining to the enactment of formative assessment. The study also contributes to the research methodological body of knowledge on classroom observation of formative assessment where researchers will be able to replicate this study in different contexts. Finally, the study contributes by way of recommending strategies to policy makers and curriculum designers and education planners on the need to integrate formative assessment in a balanced way focusing on assessment for learning to enhance the quality of teaching and learning, hence improving learners' performance.

ACRONYMS AND ABBREVIATIONS

AfL	Assessment for learning
AoL	Assessment of learning
ANA	Annual National Assessment.
ATPs	Annual teaching plans
CAPS	Curriculum and assessment policy statements
CCM	Curriculum Coverage Model
CHAT	Cultural Historical Activity Theory
DBE	Department of Basic Education
GPLMS	Gauteng Primary Schools Literacy and mathematics Strategy
HoD	Head of Department in a public school setting.
KC	Teachers' knowledge about the curriculum
KSC	Teacher's knowledge about the students and content
KTC	Teachers' knowledge about teaching and content
MKT	Mathematical knowledge for teachers.
PCK	Pedagogical Content Knowledge
SACMEQ	The Southern and Eastern Africa Consortium for Monitoring Educational Quality
SBA	School based assessment
ZPD	Zone of Proximal Development

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CHAPTER 1

INTRODUCTION AND OVERVIEW OF THE STUDY

INTRODUCTION

Formative assessment as an innovative strategy to improve teaching and learning is unquestionable (Black & Wiliam, 1998, 2009; Bell & Cowie; Popham, 2008). Hence, formative assessment has been adopted as a key strategy to improve learner performance in schools. The enactment of formative assessment within the schooling system is somewhat elusive mainly because of pseudo and dual meaning and interpretation that is attached to formative assessment (Popham, 2008). Hence, there has been growing calls for the integration of formative assessment within teaching and learning processes in order to assist teachers to use assessment to inform their pedagogy and facilitate learners' learning (Ashbacher & Alonzo, 2004; Bell & Cowie, 2001; Black, Harrison, Lee, Marshall, & Wiliam, 2004; Black & Wiliam, 1998, Popham, 2008; Stiggins, 1995; Wiliam, Lee, Harrison, & Black, 2004).

While different terms such as "formative assessment" (Black & Wiliam, 1998), "classroom assessment" (Shepard, 2008), "assessment for learning" (Stiggens, 2005) and "classroom formative assessment" (Popham, 2008), have been used to describe informal and formal assessment practices in the classroom, the essential purpose of formative assessment has remained the same. Most scholars tend to collectively refer to various strategies of *formative* assessment as misunderstandings linked to specific learning domains in mathematics. Cisek (2007: 105) notes that the effectiveness of formative assessment hinges on the "capacity of teachers to create, interpret, and use assessment information "… to guide [student] learning and instructional practices".

For the purposes of this study, formative assessment refers to that branch of assessment where the enactment of continuous assessment takes place during the teaching episodes with constant feedback provided to learners.

A growing number of assessment experts continue to claim that formative assessment serves the critical purpose of supporting learning directly (Black & Wiliam, 2006; Popham, 2008; Shepard, 2000; Stiggins, 2005). In Black and Wiliam's (1998) widely cited metaanalysis of research literature on classroom practices, formative assessment was found to have a more profound effect on learning than any other typical educational intervention, producing effect sizes between 0.4 and 0.7. However, Shepard (2006) recently noted that none of the studies in the above meta-analysis examined the effects of formative assessment utilising the latest theory on human learning and cognitive development and this is one area which this particular study explores. Brookhart (2011) also addressed the need for training teachers on current conceptions of formative assessment that reflect more recent advances in cognitive science and contemporary theories on how learners monitor their own learning. Thus, there seems to be a paucity in the literature which focuses on diagnostic aspects of formative assessment practices in general and more specifically, on the developmental aspects of learning of mathematics in the early grades.

1.1. THE STATE OF EARLY GRADE MATHEMATICS IN SOUTH AFRICA

There has been an ongoing concern about the state of primary mathematics education in schools in South Africa (Fleisch, 2008; Spaull & Kotze, 2014). Many children in the early grades and in the last year of the foundation phase struggle to advance their knowledge of mathematics. The (now suspended) Annual National Assessment (ANA) from 2011 to 2013 revealed that a significant number of early grade learners do not reach the expected levels of mathematical competencies (DoE, 2014). Distressing findings were reported by Spaull and Kotze (2014) in which only the top 16% of Grade 3 learners in South African schools were achieving at a level appropriate to Grade 3. In the same study it was reported that the "learning gap between the poorest 60% of learners and the wealthiest 20% of learners is approximately three grade-levels lower in Grade 6, growing to seven grade-levels by Grade 9" (Spaull & Kotze, 2014: 22).

The severity of early grade learning deficits was further highlighted in other studies (Spaull, 2013; Taylor, 2008; Taylor & Taylor, 2013; Venkat, 2013). Aunio, Mononen, Ragpot and Tormanon (2016) and Aunio and Räsänen (2015) as well as Fritz, Ehlert, and Balzer (2013) and Krajewski and Schneider (2009), along with numerous other researchers, argue that early *acquired* deficits are the root cause for learners' underachievement in the subsequent years. In response to what has become a crisis in primary school mathematics, Spaull and Kotze (2014) provide compelling reasons for how to address the learning gaps in the early grades. These scholars argue that if these learning difficulties remain unresolved, learners will be precluded from successful further learning and it will prevent learners from engaging fully with the curriculum that is appropriate for the relevant grades. In a meta-analytical study conducted by Fleisch (2008), several factors, such as teachers' views of learners' capabilities and teachers' knowledge of what the curriculum requires them to do, teachers' own content knowledge and their overall pedagogical expertise were identified as key determinants of effective mathematics teaching.

Conclusions emanating from studies conducted by Spaull and Venkat (2014) confirmed that the poor mathematical performance of learners was largely the result of ineffective teaching strategies arising from teachers' poor pedagogical content knowledge (PCK), which includes their knowledge of mathematics itself, in many public schools in South Africa. In the teaching and learning processes of mathematics, PCK involves teachers' competence in delivering the conceptual approach, relational understanding and adaptive reasoning of the mathematics subject content (Shulman, 1987).The study by Spaull and Venkat (2014: 126) also revealed that "79% of Grade 6 mathematics teachers showed content knowledge and understanding below Grade 6/7 level while 23 percent of South African Grade 6 mathematics teachers could answer only one of the questions correctly from the SACMEQ (2007) assessment for Grade 6 learners". These statistics must be seen against the backdrop of international mathematics teacher education literature, which advocates that teachers should, at the most basic level, have mastery of the content knowledge they are required to teach (Spaull & Venkat, 2014: 127).

Spaull and Venkat (2014:17) advance a compelling argument that "…if teachers lack understanding of the specific skills and concepts that typify struggling learners, instructional interventions that are inappropriate to meet each child's need will continue to be perpetuated". I argue that formative assessment, aimed at diagnosing learners' difficulties and developing appropriate improvement strategies, if integrated into the process of *adaptive* teaching, could support and enhance learning. Being an integrated pedagogical tool, formative assessment requires specific skills and knowledge for a teacher - *inter alia*, how children learn and develop early numerical knowledge (see Fritz, Ehlert & Balzer, 2013; Sarnecka & Lee, 2009), knowledge of typical learning difficulties (Chinn, 2014), knowledge of the concepts that children learn through mathematics facts and task procedures and also how children learn symbolically (Henning & Ragpot, 2015). My sense is that teachers who have strong PCK will be able to inflect, almost spontaneously, the pedagogical principles of formative assessment. In turn such teachers will be able to assess a learner's skill and understanding continually, and address the learners need for learning consistently as part of mainstream daily teachin. It therefore follows that teachers' pedagogical content knowledge forms the basis of effective mathematics teaching and that formative assessment is an inherent component of everyday teaching.

The enactment of formative assessment practices is crucial, in order to identify knowledge gaps, diagnose learning difficulties, perform error analysis, provide feedback and, ultimately, plan for improvement. Formative assessment is a valuable tool that enables instructors to provide immediate and ongoing feedback to improve student learning (Black & Wiliam, 1998). Formative assessment involves identifying learner's misunderstandings and helping them correct their errors through feedback during the learning process, following an assessment. The purpose of feedback is aptly amplified in the definition proposed by Ramaprasad (1983:4) as the "information about the gap between the actual level and reference level used to alter that gap". Formative feedback is crucial for improving knowledge, skills, and understanding, and is also a significant factor in motivating learners' learning. Formative assessment, to my mind, is part of teachers' pedagogical content knowledge (PCK) toolkit. There are many meta-analytical and meta-evaluation studies on the subject of formative assessment and its role in improving the quality of mathematics teaching globally.

While there are varied and inconsistent interpretations of formative assessment, I adopted the description of Leahy and Wiliam (2009) who argue that the term *formative* describes practitioners' use of assessment tools as an everyday practice. This definition implies that different types of assessment, as well as other evidence of learning and data, may be 'formative' if teachers use them appropriately to inform their instructional decisions, regardless of the intended use of the tools as determined by policy.

In addition to research on formative assessment and its role in teaching, there has been a plethora of policy reforms as well as research and development initiatives with the focus on improving primary mathematics teaching and learner performance throughout the educational landscape across all countries. In South Africa too, there have been policy changes regarding assessment practice. However, the policy changes, in my view, do not consider linkages and relationships between teachers' pedagogical content knowledge and subject matter knowledge (or even mutual embeddedness) which are crucial in establishing the impact of formative assessment on teaching in the foundation phase.

I have observed that formative assessment has been gaining traction among policymakers, teachers, and educational researchers in the schools that I visited and the meetings that I attended. The focus of this traction has been about harnessing formative assessment as an innovative strategy in improving the quality of mathematics teaching. In meetings conducted by school districts, formative assessment is seen as assisting in the planning of instruction. Authors argue that it also assists in shaping instruction as it occurs, to gauge learner achievement, and to evaluate the curriculum outcomes (Shavelson & Stern, 1981; Stiggins & Chappuis, 2008). Evidence from several studies revealed that formative assessment is instrumental in improving learning outcomes by way of influencing what and how teachers teach, and on how and what learners learn (Black & Wiliam, 1998; Cowie & Bell, 1999; Hattie, 2012; Shepard, 2008; Torrance and Pryor, 2001; Wiliam, 2011).

Despite the widespread evidence that formative assessment contributes to improved learning, I observed that there is a "poverty of practice" (Black & Wiliam, 1998) among teachers at many schools while I served as a district official. This problem is not only prevalent in South Africa but the "poverty of practice" syndrome is also a challenge in other countries such as New Zealand, United States and Australia (Black, 2007). As a subject advisor, I also observed that many teachers 'covered' content for the sake of 'ticking the right boxes' as they felt pressurised to teach a prescribed curriculum with prescribed milestones, irrespective of contextual factors, such as school location, learner profile and teacher competency. In some instances, I noticed that many teachers, at the demands of the school management team, spent far too much time and effort on preparing learners for the ANA testing, rather than pacing the teaching of the curriculum to be covered for the year. This, in my view, compromises the quality of teaching as it reduces the time and pacing for formative assessment.

My observations are consistent with research findings by scholars such as Black (2015), Earl and Katz (2006) and Lock and Munby (2000) who observed that teachers' classroom assessment practice appears to be product oriented rather than process oriented. While there is a range of factors that contribute to the "poverty of practice", the implementation of formative assessment is by no means straightforward (Black & Wiliam, 2018; Young & Kim, 2010). Young and Kim (2010: 9) assert that formative assessment is dependent upon teachers' foundational content knowledge, pedagogical understanding, instructional skill, and classroom management. Teachers' assessment practices are crucial in determining whether and how data inform instruction, deciding which data form assessments are relevant and useful to them, using the data they typically have access to, and how they integrate this with their content and general pedagogical knowledge (GPK, in the terminology of Shulman, 1987).

In this study, I therefore argue that firstly, there is a need for appropriate teacher professional development in both skills and knowledge of formative assessment, as a pedagogical content knowledge (PCK) tool (Schneider & Randel, 2010). Secondly, that an in-depth study of everyday teacher practice in mathematics classrooms is needed to observe what happens on the ground and, thirdly, to analyse these classroom practices in some detail.

1.2. RATIONALE AND CONTEXT OF THE STUDY

1.2.1. Rationale for the study

I was motivated to conduct this study as one way to find out how formative assessment practices feature in classrooms and how such practices could arguably contribute to improved learning. The concern was especially about the last year of the foundation phase. My argument is that one has to conduct a thorough analysis of everyday classroom practice in order to identify formative assessment practices that teachers use as well as specific pedagogical techniques that they may include as part of their PCK toolkit. I maintain that without formative assessment that is based on understanding children's learning progression (or conceptual development) the practice of doing it may remain mechanical and oriented to adhere to a policy of 'continuous assessment' as is required by policy. I have realised that a descriptive case study of four different Grade 3 classrooms may shed some light on what happens on the ground when the curriculum is activated.

Although there are a number of studies that report on learning outcomes in South Africa, it is mostly in the work of Graven and Venkat (2007, 2014) and lately also of Askew (2012) that classroom teaching and mathematics have been reported on practice in some depth. Other studies capture outcomes and achievement of learners, but I would argue that these studies refrain from inserting developmental aspects of, for instance, early number concept development and remediation as well as formative assessment practices as described by Fritz et al. (2013). Studies that I have already mentioned, such as those conducted by Spaull (2013), Spaull and Kotze (2015) as well as those by Pritchett and Beatty (2012), Aunio and Mononen (2016) and Banerjee and Duflo (2011) serve as a reminder of the impact of learning difficulties in the early years as the primary cause of learners' underachievement in later years of foundation phase learners (Aunio & Räsänen, 2015). These authors further argue that any attempts to improve learners' mathematical proficiency should first focus on addressing possible learning difficulties of individuals (or groups) if they are to be successful.

The problem of formative assessment was the object of a study conducted by the Educational Testing Services (ETS) in the USA and showed that different teachers found different techniques and assessment for learning strategies useful (Leahy, Lyron, Thompson & Wiliam, 2005). What worked for some teachers did not work for others, despite the researchers having discussed specific approaches and techniques which teachers could use in their classrooms to foreground formative assessment. The study confirmed that formative assessment is not recipe-driven and that there could be no one-size-fits-all approach. Given this variability, Leahy *et al.* (2005:21) suggest that it is important to offer teachers "a range of techniques for each strategy, making them responsible for deciding which techniques they will use and allowing them time and freedom to customise these techniques to meet the needs of their learners". It became evident in the study that teachers have tried out, adapted, and invented several techniques, reporting on the results in meetings and interviews. It is results like these that motivated me to conduct a close-up analysis of classroom practice.

1.2.2. Context of the study: mathematics classroom instruction

The aim of mathematics teaching in the foundation phase, as encapsulated in the definition of mathematics in the Curriculum and Assessment Policy Statement (CAPS) (DoE, 2011a), is dependent upon specific processes and a specific context. The recurring emphasis in the definition of mathematics as proposed in CAPS is that the classroom environment must be able to foster collaborative learning, conceptual understanding and 'critical thinking of mathematical ideas. The definition of mathematics as encapsulated on CAPS is as follows:

> Mathematics is a 'language' that makes use of symbols and notations for describing numerical, geometric and graphical relationships. It is a human activity that involves observing, representing and investigating patterns and qualitative relationships in physical and social phenomena and between mathematical objects themselves. It helps to developmental processes that enhance logical and critical thinking, accuracy and problem-solving that will contribute to decision-making. (DoE, 2011a)

Based on the above definition, the type of activities most compatible with the aims of mathematics are exploration, experimentation, engaging learners in mathematical discourse and creating opportunities for collaborative as well as individual learning. I argue that mathematics as defined by DoE (2011a) is pluralistic, comprising the outcomes of learning, the processes and the context where the teaching takes place. In my view, formative assessment, which is process oriented, is pivotal in achieving the 'end products' (outcomes) of learning, which is childrens' conceptual understanding, and their competent use of procedural knowledge and mathematics facts in problem solving, and critical thinking, the latter of which implies the ability to look at the very object they are learning from an evaluative point of view. If learners are not assisted in their learning trajectory by way of formative assessment and the feedback-support loop, and if needed, also remediation - they are unlikely to reach the stage where they can conceptualise mathematics knowledge as an abstract phenomenon and reflect on it critically. The aims of the curriculum are encapsulated in the definition of mathematics (DoE, 2011a), yet it is unfortunate that these aims are not fully actualised in mathematics teaching (Ensor, Hoadley, Jacklin, Kuhne, Schmidt, Lombard & Van den Heuvel- Panhuizen, 2009; Fleisch 2008; Spaull & Kotze, 2014). Implied in the definition of mathematics is inference that mathematics teaching entails a number of processes which must be followed to ensure attainment of the learning outcome. Formative assessment is one of the process (or tool in the PCK toolkit of the teacher) that takes into account the classroom context/setting by focusing on the process of teaching towards the achievement of the product or outcome (Black & Wiliam, 2009). In order to support learners where there are obstacles in the way of progress, one has to assess them and give feedback support within the individual's *zone of proximal development* (Kozulin, 2017; Vygotsky, 1978). Findings in a study reported by Ensor et al. (2009), across Grade 1 to Grade 3 teachers' classroom practice in mathematics, revealed that the practices privileged concrete modes of representation, resulting in a significant number of learners who were increasingly dependent on concrete strategies for solving problems at Grade 3 level and that formative assessment could have been a warning mechanism for the teachers to see that they are not utilising formative assessment to scaffold learning and to work towards abstract knowledge.

Furthermore, it was also evident in this study that very little attempt was made by teachers in the lower grades to encourage calculation without counting. It is the expectation that effective formative assessment requires a teacher to advance beyond the current state of understanding/competence of a learner and to refrain from only counting as a calculation tool. Another finding from this author's study was that the majority of teaching time focused on whole class teaching across all three grades, which means that individual or small- group formative assessment was not enacted in general. Similar findings were observed in a study of Grade 3 teachers, which indicated that teachers' practice was inconsistent with the pedagogical practice stated in the South African curriculum (Roussouw, 2010).

The South African curriculum requires teachers to promote opportunities that engage learners in problem solving, logical thinking, to recognise patterns, and to implement a type of pedagogy that focuses on conceptual understanding, all of which have opportunities for formative assessment – responding to the needs of learners by capturing where their strength and their vulnerabilities lie. Through systematic observation of classroom interactions and interviews, the researchers found that teaching practices of many Grade 3 teachers were not in accordance with expectations of the curriculum with regard to the enactment of assessment within their pedagogy. Based on these findings, Roussouw (2010) proposed that teachers should unlearn the mathematics teaching which they know, in order to develop new ways of thinking about mathematics and new ways of learning it.

The under-utilisation of the formative assessment 'connections' in mathematics teaching resonates with the meta-analytical findings which indicate that "primary mathematics teachers often provide limited opportunities for learners to understand mathematics in coherent ways" (Venkat & Naidoo, 2012: 26). This study also showed a disconnection in teaching sequences and a lack of teacher awareness of learners' conceptual progression in the teachers' teaching from more concrete to more abstract. Venkat and Naidoo (2012) also observed a lack of coherence between lessons, within lessons and haphazard selection and sequencing of activities that mitigate against conceptual understanding.

Contrary to the notion of sequential learning, Young and Kim (2010) argue that while content knowledge develops in a sequential manner, not all learners grasp content in the same way and teachers will only know how learners progress (or not) by assessing them consistently to help form an idea of where each learner is in their own progress. Some learners progress towards achieving an in-depth understanding of mathematical concepts and procedures in a sporadic and disjointed manner. Young and Kim (2010: 9) therefore claim that for assessment to be used formatively, teachers need to identify relevant assessment data and use the data to establish learners' emerging understanding and "individual learning trajectories, and then adjust instruction accordingly".

Teachers' understanding of learners' emerging ideas guides teachers to establish parts of previous instruction that needs additional emphasis, and how to scaffold and tailor instructional activities to improve learning. Some studies revealed that teachers with strong mathematics content knowledge are better able to adapt to learners' needs by identifying knowledge gaps within the learners' knowledge acquisition/construction trajectory (Aschbacher & Alonzo, 2004). Teachers with strong subject matter knowledge manage to efficiently apply their knowledge flexibly by simplifying concepts and use alternate strategies for struggling learners. Such teachers also have a reasonable understanding of their learners and are quick at identifying the different entry points for different learners, and are able to match the content with learners' understanding and misconceptions accurately. The importance of an understanding of learners' thinking was amplified by Fennema, Franke, Carpenter and Carey (1993) in their Cognitively Guided Instruction (CGI) project. The researchers in the CGI project found that teachers who used problem-based learning were able to better understand how children think and were able to apply their knowledge about children's mathematical thinking in their teaching. Problem based learning is a strategy that "organises mathematics instruction around problem solving activities and affords learners more opportunities to think critically, present their own creative ideas, and communicate with peers mathematically" (Roh, 2003:2). Learning is driven by problematic mathematics rather than by the memorisation of facts and procedures. Learners no longer seek single answers, but they instead gather information and identify different solution methods, evaluate their options, and then present a solution.

The ultimate goal of mathematics teaching is to promote conceptual understanding. Learners understand mathematics when they invent and examine their own solutions for solving mathematical problems, which is what problem based learning strives to achieve. It became evident in the study that the most competent teachers used problem-based learning to extend the curriculum and to tailor instruction to learners. Moreover, the more competent teachers "did not base their decisions on a formal hierarchy" of mathematical concepts; instead, they reconstructed their content knowledge according to learners' needs (Fennema et al., 1993: 559).

Based on research evidence such as the examples I have mentioned, many of the problems associated with foundation phase teaching in South Africa appears to be at the level of 'mediational' practice (Askew, 2012; Spaull, 2013; Venkat & Naidoo, 2012).
In essence, mediational practice means the operationalisation of PCK, which includes continuous formative assessment. I argue that this shortcoming is specifically the issue of ineffective or non-existent formative assessment skills and lack of understanding that formative assessment is inherent to effective teaching, with teachers typically assessing

to assign scores and not to note or diagnose a need for scaffolding for learners. This phenomenon of assessing to fill in a required score sheet is deeply flawed, I would argue, and constrains the intended purpose of assessing to help a child from knowledge of procedures and of concepts (Brookhart, 2018). Moreover, many teachers give learners test results with mostly impressionistic information without feedback that can help them form or reform their knowledge (Cizek, Fitzgerald & Rachor, 1996; Shavelson & Stern, 1981). Neesom (2000) found that teachers consider formative assessment as an 'add-on' to their everyday instructional obligations, and Daws and Singh (1999: 74) pointed out that "few teachers explicitly use assessments formatively as part of their instructional practice, despite their general awareness of the assessment's potential advantages".

The authors mentioned in the preceding paragraph, also observed that, during the marking of learners' work, teachers used the scoring 'evidence' to assign grades instead of using the evidence to identify learning gaps and plan appropriate activities for subsequent instruction which is a purpose of formative assessment. I argue that formative assessment is a powerful PCK mediational tool that responds to learners' learning needs through the process of confirming where the learner is in the learning, where the learner is going to and how the learner can get there with some assistance (Black & Wiliam, 2009). Formative assessment has the potential to overcome many of the problems associated with the teaching of mathematics in the early grades.

1.3. THE RESEARCH PROBLEM: LIMITED KNOWLEDGE OF TEACHERS' FORMATIVE ASSESSMENT CLASSROOM PRACTICE

The problem that was investigated in this study is the lack of a comprehensive description and analysis of formative assessment classroom practice in local schools. I situated the research problem empirically in four purposefully selected schools. I identified four public schools as the setting of this case study to examine teachers' enactment of formative assessment. Two of these selected schools were "priority" schools, while the other two schools were "non- priority' schools. The categorisation of the schools into "priority" and "non-priority" was based on the results of the systemic standardised Annual National Assessments (ANA's) conducted by the Department of Basic Education on all public schools in South Africa.

Most classrooms in the “priority” schools have a number of over-age learners who are not yet academically ready for the grade but have been progressed to the grade based on age cohort. The criteria of age cohort as stated in the National Policy Pertaining to the Progression and Promotion of Learners in Grade R to 12 (DoE, 2011b) emphasises that no learner may repeat a grade more than once in a phase. This, therefore, implies that learners who have already repeated a grade in a phase and have still not achieved the learning outcomes cannot be retained in the grade, but has to progress to the next grade because of the policy requirement. Hence, learners who have previously repeated a grade within a school phase, and have not yet met the promotional requirements for the grade, will have to progress to the next grade based on age cohort. Hence, the learners who have progressed into the grade without meeting the promotional requirements have huge learning gaps which have accumulated from their previous years in school. While teachers are expected to provide interventions for learners who are performing at different levels, it is unfortunate that this is seldom practiced because teachers adhere rigidly to the prescribed lesson plans. I further argue that effective formative assessment embedded in everyday teaching may mitigate the problem of accumulated learning deficits among learners as supported by empirical findings in studies conducted by scholars such as Black and Wiliam (1998) and Spaul and Kotze (2015).

Although there are studies that investigated teachers’ mathematical knowledge and skills on selected aspects of formative assessment, such as either teachers’ questioning ability, ability to interpret learners’ answers, ability to provide feedback or to plan the next step in instruction, these studies were conducted during teacher education training (Schneider & Randel, 2010; Son, 2013), and not during authentic, everyday classroom practice, such as one would do in a case study, where the *bounded system* (Stake, 2005) would be whole mathematics lessons in sequence in everyday practice.

In this study, I therefore argue that there is a need to investigate teachers’ enactment of formative assessment in authentic classroom practice to explore the teaching of mathematics in Grade 3 and to identify consistent formative assessment practices.

1.4. AIMS AND OBJECTIVES OF THE STUDY

The aim of the study was to explore how Grade 3 teachers practice formative assessment when teaching mathematics. In order to realise the aim of the study, the study's objectives are:

- To explore Grade 3 teachers understanding of formative assessment.
- To examine what teachers know about how children learn mathematics and how their conceptual and procedural understanding of mathematics develops
- To understand how Grade 3 teachers use their knowledge of children's thinking to shape their formative assessment practices in mathematics.
- To ascertain what support is required by Grade 3 teachers to operationalise the concept of formative assessment in mathematics teaching

To achieve the objectives set out above, I formulated the following research questions for my study:

1.5. RESEARCH QUESTIONS

The main question for this study was:

- How do Grade 3 teachers practice formative assessment in mathematics teaching?

The sub-questions for investigation were:

- What do Grade 3 teachers know about the purpose of formative assessment in mathematics teaching?
- What do Grade 3 teachers know about how children learn mathematics and how their conceptual and procedural understanding develops?
- How do Grade 3 teachers use their knowledge of childrens' thinking to shape their formative assessment practices in mathematics?
- What support is required by Grade 3 teachers to operationalise the concept of formative assessment?

1.6. FRAMEWORK FOR THE STUDY: FORMATIVE ASSESSMENT AS MEDIATIONAL 'TOOL-USE'

The primary analytical framework for this study is a sociocultural theory, specifically contemporary cultural-historical activity theory (CHAT) with its emphasis on the mediational function of tools in human activity. Formative assessment is viewed as such an activity, situated in the community of a classroom. Formative assessment is not only a technical instrument but comprises a complex *process* which embraces activities ranging from pedagogical *tool*-use, as described in classical Vygotskian theory (Kozulin, 2017; Vygotsky, 1978:1986), teachers' understanding of assessment standards, their formative feedback to learners, individually and collectively, and creating opportunities for engaging classroom conversations (Venkat & Spaull, 2015).

Furthermore, contemporary sociocultural theory, as manifested in cultural-historical and activity theory (CHAT), includes the notion of an *activity system* (Engeström, 1991, 1999). I used this theoretical and analytical lens because it draws upon the primacy that assessment *activity* is understood as a "collective system" which constitutes 3 elements; "motives, actions and operations" (Engeström, 1991). CHAT centres on the idea of interaction between a person or group (*subject*), a goal, motivation, or problem (*object*) and mediational interaction with tools as well as they intersect with the activity system (which, in the case of this study will be two systems in two different school classrooms). A key feature of activity theory (AT) in a sociocultural and historical perspective (CHAT) is the reciprocal interaction of the three aspects of an activity, such as, for example, formative assessment during mathematics teaching of Grade 3 learners, as well as their social and semiotic dimensions, and the *rules* of the system, the *community* of the system and the *division of work/labour* in the system (see Figure 1.1). In the study, I describe different classes (in Grade 3) to see how their *activity* (formative assessment practice) intersects, which will be explained in the research design in chapter 3.

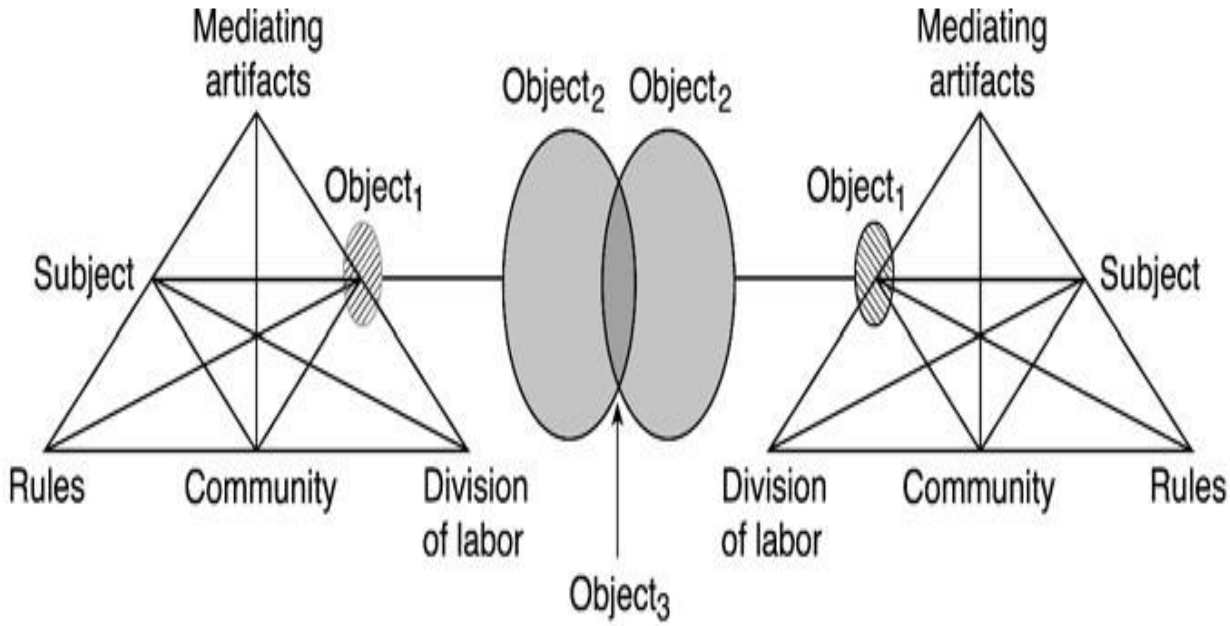


Figure 1.1: Two interacting activity systems (Engeström, 2001: 136)

Through the analytical 'lens' of CHAT, the subject's understanding of the object may change as they interact with different tools (Engeström, 1991). Conversely, a subject's (the teachers in this case) understanding of their role in the system may change as a function of the interaction with tools and objects.

In considering formative assessment in a classroom as an activity system, the object proposed is enhanced learning through practicing (engaging with) usable strategies for enacting formative assessment teaching. This type of activity can subsequently be converted into a range of outcomes that emanate from reaching the objective/object. This can include feedback that results in the correction of errors, identification of learners' misunderstandings, affirmation of conceptual changes, and may contribute to learner's metacognition and self-regulated learning.

Studies conducted by Fleer, Anning and Cullen (2004) on the effects of the context on the social group interaction showed that the way the children use tools such as language, or a particular action or resource to mediate knowledge in interactions with others are influenced by the sociocultural features of the context, which, in turn, influences the way activity (in the CHAT sense) is performed/realised. (See Figure 1. 2, Shingenge, 2017).

Edwards (2007) argues that learning is essentially a cultural activity, in which learning takes place in the context of cultural expectations, as mediated through signs and tools.

Formative assessment: The 'assessment triangle'

As illustrated in Figure 1.2. on the following page, the relationship between learners and a school culture; and expectations is important for a learner's success, and assessments should be interpreted, bearing in mind the context formed by the backgrounds and experiences of learners and teachers who are part of it. According to Elwood (2007), any study of formative assessment practices or interventions must take these sociocultural influences into account as background to the learner (object of activity)

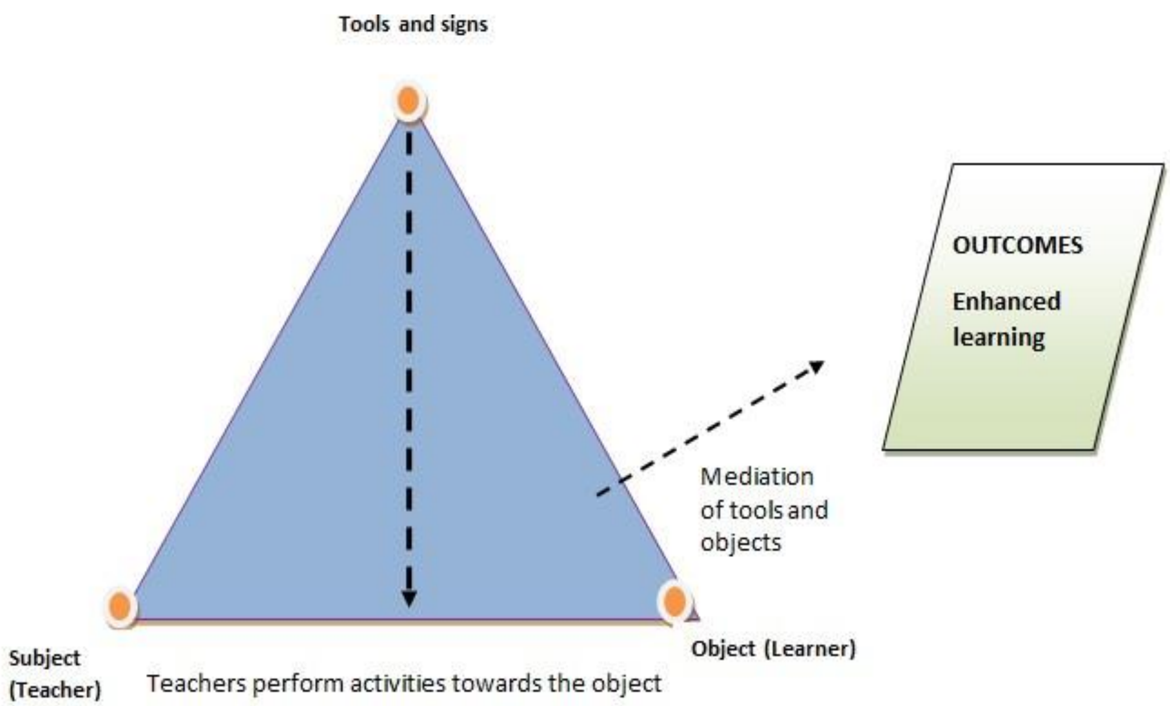


Figure 1.2: Semiotic mediation in the activity of formative assessment (Adapted from Shingenge, 2017)

Cole and Engeström (1993:43) recognise that "there are many voices, views, and traditions influencing a system". Within the activity system of the classroom, these influences can significantly alter expected outcomes for learners. The variation in the teachers' mediation and application of the tools and the manner in which the learners use the tools may affect the expected outcomes. With this in mind, the rules influencing the activity system might include teachers' expected understandings of learning, or subject-based views about the teacher's own particular pedagogy and, of course, understanding of formative assessment pedagogy, specifically for teaching mathematics.

Black and Wiliam's (2009) theory of formative assessment refers to the three core pillars of assessment, namely *cognition*, *observation,* and *interpretation* as conceptualised in the 'assessment triangle' proposed by Pellegrino, Chudowsky and Glaser (2001). The assessment triangle model (Pellegrino *et al.*, 2001) is relevant to this study as it provides a basis for the design and implementation of theory-driven instructional and assessment practices which is then integrated with the primary framework of CHAT.

The cognition element refers to the theory or the set of beliefs about how learners represent knowledge needed in a particular subject and are useful in drawing inferences about children's thinking. The identification of a set of knowledge and skills to measure a task in any assessment application is crucial to guiding instruction in order to increase learning. James (2006) points out that effective assessment requires teachers to have a clear understanding of typical ways in which learners represent knowledge and develop expertise in a domain. Webb (1992) cited by James (2006) states that these findings could be obtained from cognitive and educational research about how people learn as well as from experiences of expert teachers. Relevant theories of cognitive development will be explored to understand how children learn which would help teachers to diagnose particular difficulties learners experience in a particular domain.

The observation element represents a set of specifications for assessment tasks that will provide evidence of learners' understanding. Hence, the kinds of the task to which learners are expected to respond to must be carefully designed to provide evidence of learners' thinking. In formative assessment, evidence of learning is usually observed through discussions, questioning, written work, demonstration, and direct and indirect observation. The interpretation component of the triangle encompasses all the methods and tools used to reason – to think about - from what could be fallible observations. In formative assessment, the interpretation of the teacher is mainly informal and is usually based on a personal, intuitive qualitative model rather than a formal statistical model as in the case of summative assessments.

Pellegrino et al (2001) emphasise the importance of the connecting relationships between all three elements of 'assessment triangle' to ensure effective assessment and sound inferences. When the knowledge derived from both the cognitive and observation perspective is combined, relevant information is more likely to be collected from the tasks. Knowledge of the cognitive theory of how young learners develop concepts and cognitive skills provides clues about the types of situations that will *elicit evidence* about their competence, transforming data about learner performance into assessment results. The interpretation element expresses "how the observations from a given task constitute evidence about the performance being assessed as it bears on targeted knowledge" (Pellegrino et al., 2001: 36).

Having firstly considered mathematics teaching as the context for investigating teachers' enactment of formative assessment, and secondly, having noted that assessment does not take place in isolation but is informed by both curriculum and instruction as well as classroom context, I found that the mathematical knowledge for teaching model (Ball, Thames, & Phelps, 2008) relevant to understand the role of curriculum and instruction in the process of my inquiry – once more placed within the overall 'zoom' of the lens of CHAT. Since the focus of the study is mathematics teaching, I will refer to the *mathematics knowledge for teaching* (Hill, Ball, & Schilling, 2008; Ball et al., 2008) notion as a part of the broader heuristic that I will use for analysis of formative assessment. The rationale for including the mathematical knowledge for teaching (MKT) model in the 3- dimensional frame for this study is based on the following:

- Firstly, MKT differentiates between two branches of pedagogical knowledge (PCK) i.e., subject matter knowledge (SMK) and pedagogical content knowledge (PCK). This distinction will guide me in drawing linkages between pedagogy and the role of subject matter knowledge in best practices in formative assessment.
- Secondly, the role and importance of teacher knowledge about the students and content (KSC), teachers' knowledge about teaching and content (KTC) and teachers' knowledge about the curriculum (KC) is explained coherently in so far as understanding how the different types of pedagogical knowledge required by teachers can be harnessed to improve their formative assessment practices.

- Thirdly the KSC domain refers to the knowledge that combines knowing about students and knowing about mathematics (Ball et al., 2008: 401) which is significant in anticipating learners' difficulties, understanding learners' reasoning, and knowing common errors and misconceptions that learners will have with specific content. KTC is significant to formative assessment practices as it is manifested when teachers initiate classroom discussion, pause for more clarification, use a learner's remark to make a mathematical point or ask questions, or pose a new task for students learning (Ball et al., 2008). Teaching activities are dependent on the teachers' deep understanding of the subject of mathematics, as well as their understandings of how their instruction will impact on students' learning (Ball et al, 2008).

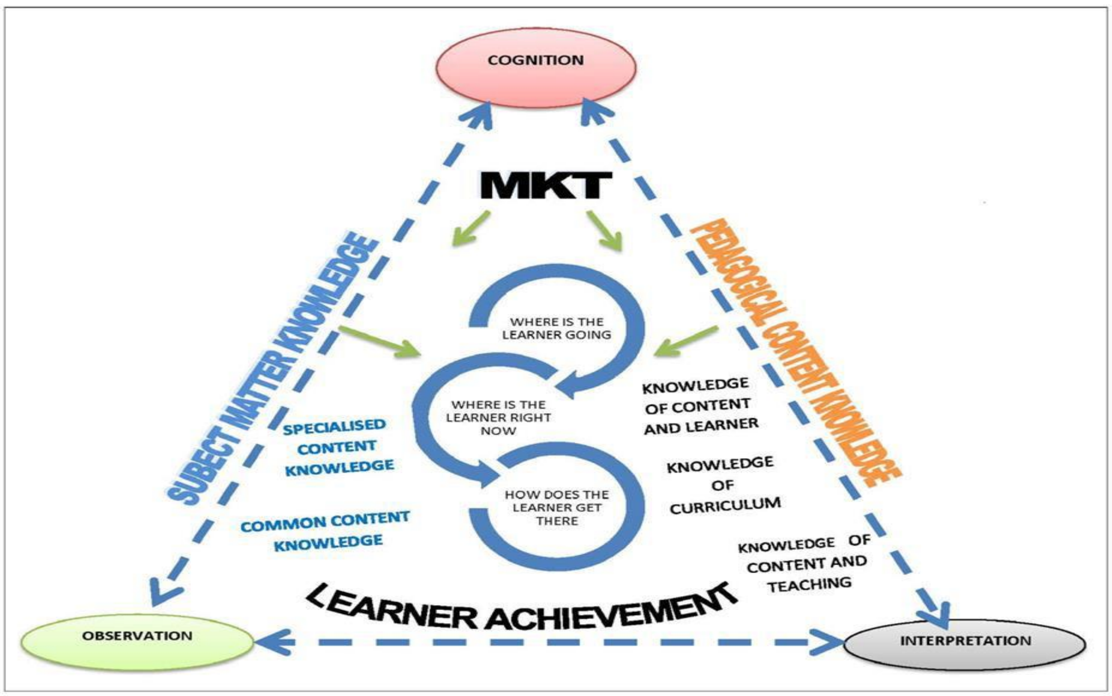


Figure 1.3: The assessment triangle. Source (Adapted from Pellegrino, Chudowsky & Glaser, 2001:67)

Figure 1.3 illustrates a conceptual framework that I followed by integrating salient concepts related to mathematics education, formative assessment and the pedagogy of mathematics teaching. I also considered aspects of CHAT as well as the components of the conceptual framework in Figure 1.3. when I compiled the observation protocol, the interview protocol and eventually, the schedule and frame for data analysis.

1.7. RESEARCH METHODOLOGICAL ORIENTATION: CLASSROOM CASE STUDIES

1.7.1. Research design

To study two (adjacent) activity systems in four classrooms, a case study design can yield optimal data about teachers' formative assessment practices. A case study is described as an empirical inquiry that "investigates a contemporary phenomenon" such as formative assessment, within everyday context (Yin, 2009:18), identifying the "bounded system" (Stake, 2005) with specific parameters and a specific unit of analysis. Case studies also enable researchers to capture the complexity and situatedness of behaviour and gain rich and 'thick descriptions' of the phenomenon (Cohen, Manion & Morrison, 2007:85). Case studies have been described as best suited to research that asks "how" and "why" questions (Stake, 2005; Yin, 2003), responses to which would include data on teachers' activity and their explanations of what they do and why they invest in certain practices. However, whilst there may be other factors that contribute to learner performance, this study focused specifically on teacher's enactment of formative assessment, which sets the boundaries of the case (the bounded system) and the unit of analysis, which in CHAT includes not only the unit of sampling, but the *activity* in which *subjects* (teachers) engage (Kozulin, 2017) in an activity system. The bounded 'system' is thus a system within the activity system itself. This design will enable me to explore each setting in an attempt to obtain a more comprehensive understanding of the research phenomenon (Creswell, 2007:238) that has motivated me to conduct this inquiry.

The strength of a case study is that it allows the use of a variety of research methods, which are likely to strengthen the reliability of the study and the validity of the findings. In this study, various data collection methods, including observation, document analysis, and focus group interviews as well as stimulated recall interviews with teachers were utilised (Henning, Van Rensburg & Smit 2004, Yin, 2009). Babbie and Mouton (2014:293) suggest that the typical methods of qualitative case studies will allow the object of the study to speak for itself rather than providing participants with hypothesis-based questions and observation protocols (Babbie & Mouton, 2014:293). Initial observation of an activity provides specific incidents and behaviour that can be used as reference points for subsequent interviews and other forms of data gathering. It is also a helpful strategy for understanding complex phenomena (Merriam, 2009:119) such as inclusive education, which assumes a consistent formative assessment.

Classroom observation was undertaken during four consecutive lessons on a specific topic in the curriculum to capture the 'activity'. A selected number of lessons were video recorded for later stimulated recall interviews (Juuti &Lavonen, 2006) with the two teachers individually. Dyadic interviews with the four teachers together provided in-depth information pertaining to participants' experiences and viewpoints of the phenomenon/activity. The strength of the dyadic interview is in the conversational interaction. Document analysis enhances data collected through in-depth interviews (Bowen, 2009:27). Documents that were analysed include learners' written output, teachers' lesson plans, assessment recordings, government and departmental curriculum policies, minutes of departmental meetings, minutes of departmental official meetings.

1.7.2. Sampling

Having considered Merriam's (1998) suggestion that a qualitative study requires a sample from those people who possess special experience and who are assumed to be competent representatives of the topic under study, so as to provide insights for understanding and discovery, I followed the purposive sampling route to intentionally seek for an "information-rich case" (Merriam, 1998: 48). The sampling process involved the following steps, all guided by the empirical (but also epistemic) question: which case provides me with the "best opportunity to learn" (Stake, 2005:446) about the activity? It will commence with identifying an appropriate school district within the Gauteng Province from which information-rich cases could be drawn. I decided on the Tshwane South District as this district was one of the districts that participated in the Assessment for Learning (AfL) professional development programme which was facilitated by the Tshwane University of Technology. AfL is a term used synonymously with formative assessment (Harlen, 2007). Both "priority" schools, as well as "non-priority" schools, attended professional development workshops on AfL. However, the priority schools attended a series of workshops presented by the AfL programme developers who were academics from the Tshwane University of Technology, while teachers from non-priority schools attended fewer workshops and were trained by the District officials.

The next step was to identify schools that were information-rich within the district. The selection of the sample began by identifying 12 Grade 3 teachers from the identified district through purposive sampling. The following criteria were used to guide the selection of the eight teachers, namely; six teachers must be selected from the category of "priority schools" whilst the other six teachers must be selected from the category of "non- priority" schools; teachers must have appropriate foundation phase qualification with more than three years of experience in teaching Grade 3. These criteria were important as it ensured that the teachers would have adequate knowledge about teaching and mathematics curriculum and would have experience with pedagogy. Given these criteria, the selection of the teachers was made through the recommendation of the district officials. Two focus group interviews comprising of six teachers, representatives of both priority and non-priority schools were conducted. Based on the responses of the teachers in the focus group interviews, four teachers from four different schools were purposively selected for classroom observations. It was important for me to identify teachers who demonstrated some understanding of formative assessment to identify formative assessment episodes from which to draw from for the analysis in the study. In addition to the selected teachers, two HODs representing the selected schools were also selected. Two subject advisors from the district were also identified to address the context of the schools where necessary.

1.7.3. Data collection

Data collection began by conducting two focus group interviews with the twelve identified teachers. Focus group interviews were audio recorded and later transcribed. This phase of data collection elucidated how teachers' formative assessment is framed through their knowledge base, before the actual teaching. Insight into the teachers' orientation to mathematics teaching, teachers' knowledge of learners' understanding, mathematics curriculum, instructional strategies and representations, and assessment methods will be understood. The simulated recall interviews followed mid-way through the research period, which commenced in January 2017 to the end of June 2017.

Data was also collected through classroom observation. Four sequential lessons were observed for each teacher in order to capture the teaching of a topic from beginning to end and to obtain a complete picture of their formative assessment practices. Using Black and Wiliam's (2009) model of formative assessment, it allowed me to identify formative assessment episodes as not all activities were formative, but information sharing and instructional. The notion of a formative assessment episode refers to the activities that provide information, which can be used as feedback by teachers (Black, Harrison & Lee, 2003).

In locating the formative assessment episodes within the teaching activities during a mathematics lesson, I was able to observe the teachers' pedagogical content knowledge in each formative assessment episodes, using components of the MKT model. The observations helped me to examine how teachers translate their PCK during their formative assessment practices as they adapt their lessons to meet learners' needs. All the lessons were video recorded and observation notes were taken during each class session. Stimulated recall interviews with teachers were conducted to probe teachers' thinking and understanding in terms of the relationships between their knowledge domains. At this stage, teachers, elaborated and clarified practices were observed when teaching while watching episodes of themselves teaching. Reflection is necessary for teachers' empowerment in general and for making sense of their teaching practices in particular (Babbie & Mouton 2014). It is through these interviews that teachers' perceptions of the formative assessment were elucidated. Additional information was gleaned through analysis of documents, including teachers' lesson plans, assessment recording, minutes of departmental meetings and learners' workbooks. Analysis of lesson plans was used to confirm data collected from teacher's interviews and classroom observation and was provided as evidence about the nature of teacher's written feedback and error analysis pertaining to formative assessment. These documents were used to assist in the description of the episodes and to support the transcriptions and analysis with clarification.

These multiple data sources enabled me to engage in data triangulation, offering varied sources of data. Data triangulation provided me with a comprehensive picture of formative assessment practices which was more varied than a single data source. The use of multiple data sources is also congruent with the principles of activity theory and case study methods which requires the use of multiple data collection methods to provide the perspective required for an understanding of complex phenomena.

1.7.4. Data analysis

I applied basic principles of qualitative content analysis, which Creswell (2007:237) describes as “thematic analysis” while trying to invoke aspects of discourse analysis as described by Henning, et al. (2004). The ‘raw’ data was organised and prepared per data source by identifying segments of data that are responsive to the research question and sub-questions (Merriam, 2009:176) thus comprising data sets from the classroom observation, interview transcriptions, observation notes and documents I had gathered. The identified data was then segmented into meaningful units and coded in broadly grounded theory, inductive mode (Strauss & Corbin, 1998; Henning et al, 2004).

1.7.5. Trustworthiness

The trustworthiness of this research study was established, firstly, by means of a detailed ‘chain of evidence’ from ‘raw’ data to final themes (Henning et al, 2004), which could lead to dependability (reliability) for potential use by subsequent researchers. (Babbie & Mouton, 2014; De Vos, Strydom, Fouche & Delport, 2002). Credibility (internal validity) was established by means of triangulation across different data. Transferability (external validity) was not fully achieved, as the sample size was small and did not go beyond exploration and description.

1.8. ETHICAL CONSIDERATIONS

Ethical-measures, as required by the University of Johannesburg, was applied during the course of this research and ethical clearance (see Appendix A) was obtained from the relevant committee at the university. I sought permission from the Gauteng Department of Education to undertake research in the selected schools (see Appendix B). I also obtained permission from the director of the selected District (Tshwane South District) and the principals of the selected schools (see Appendix D and Appendix E). All participants were fully informed of the nature of the study and informed consent was obtained from all research participants (see Appendix C and Appendix F) Participants were informed of the general nature of the investigation, their role in terms of time and effort, and procedures to be used to protect their anonymity and confidentiality (Mouton, 1996:47).

I ensured that the collection of the data remained anonymous and confidential, and "participants' names and identities were not linked to the findings" (McMillan & Schumacher, 2010: 366). Hence to prevent identification of school, teacher or subject advisors, the informants were referred to by fictitious names/pseudonyms in the study. In chapter 3, I discuss in greater detail the measures I followed to ensure ethical research practice.

1.9. THESIS OVERVIEW

This thesis is organised under the following chapters.

Chapter 1: Orientation and background to the study, theoretical perspectives, and research methodology.

Chapter 2: Review of the literature. I examine the literature on formative assessment and mathematics pedagogy, coupled with a description of the Cultural Historical Activity theory as a framework for the study.

Chapter 3: Methodology of the study, which includes the research question, sampling, data collection, data analysis and research ethics.

Chapter 4: Presentation of research findings. "Raw" data is used throughout this report as exemplars of the voices of the research population.

Chapter 5: Discussion of the findings, implications for practice, research and policy are presented.

1.10. CONCLUSION

A central argument of this thesis is that teachers do not enact formative assessment because of the multifarious tensions that exist in the activity system (schools). The school is a system which comprises many interdependencies which aggregate to constrain the way teachers plan, design and implement formative assessment. Amongst others, some of the constraints teachers face are related to compliance, prescribed implementation of scripted lessons, poor in-service and pre-service teacher training. This study focuses specifically on how Grade 3 teachers enact formative assessment in mathematics classrooms.

CHAPTER 2

FORMATIVE ASSESSMENT AND MATHEMATICS PEDAGOGY: THEORY PERSPECTIVES AND EMPIRICAL FINDINGS

2.1. INTRODUCTION

In this chapter, I present discussions and discourses about formative assessment that I drew upon for the study. As mentioned in the previous chapter, the unit of analysis (Trochim, 2006:13) of the study is teachers' classroom practice with the purpose of understanding what explains their pedagogy of formative assessment in the teaching of mathematics. The argument of the chapter is that although teachers may know about formative assessment if they do not understand how children learn and engage in mathematics learning, they are unlikely to enact formative assessment. To situate the study in a literature search that will advance this specific argument, the chapter will include discussions about the purpose of classroom assessment, formative assessment as a pedagogical tool, studies on formative assessment, the pedagogy of mathematics and formative assessment, and teachers' understanding of how learners learn mathematics. The chapter then concludes with the professional aspects of a teacher with a focus on teacher agency and professional development drawing the conclusion that teachers may enact formative assessment techniques with the coherent activities of the classroom system.

The chapter is rounded off with an argument for a specific type of teacher agency that is fundamental to formative assessment, one that would allow teachers the flexibility to exercise their autonomy, to become innovative, without having to be concerned about the pressures of curriculum coverage expectations. Teachers are less likely to enact formative assessment successfully if they are expected to complete the curriculum that does not take into account the learning pace of learners. The development of the chapter is set out in Figure 2.1.

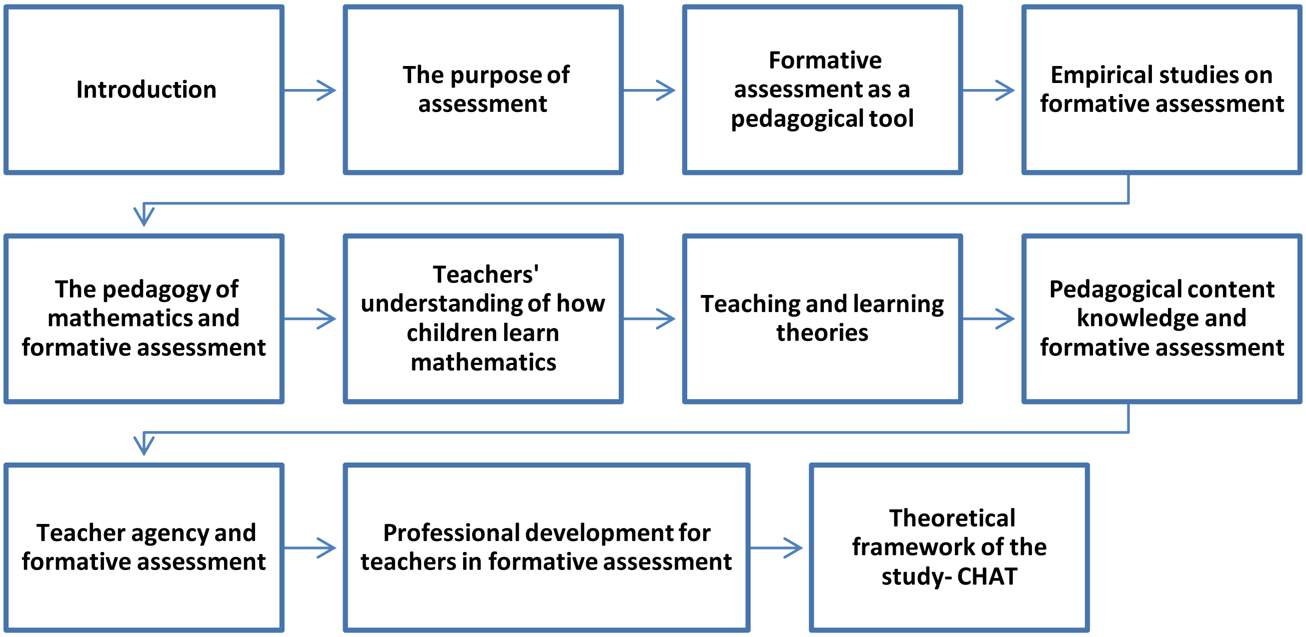


Figure 2.1: The structure of Chapter 2

2.2. THE PURPOSE OF ASSESSMENT

Assessment has for long been considered an integral part of the process of teaching and how it intersects with learning (Stiggens, 2005; Swaffield, 2011). Assessment is used for different reasons, in a variety of contexts and has utility for different stakeholders (Black & Wiliam, 2018; Heritage, 2010; Sadler, 2010). Izard (1993) explains assessment in terms of assessing learner performance and skills mastered. Stiggens (2002) focuses on the value and use of information during the process of assessment. Rowntree (2015) emphasises the diagnostic nature of assessment and argues that the design should be aligned to its intended purpose. Wiliam and Thompson (2017) posit that assessment is about organising a situation to gather information which is then interpreted to reveal something about the learners' personal knowledge and skills.

Based on the above interpretations of assessment, it is evident that assessment occupies a crucial role in the classroom as it is aimed at establishing whether learners have achieved the outcomes and to what extent outcomes have been achieved.

The process of establishing to what extent outcomes have been achieved and how to support learners to achieve the outcomes requires a diagnostic approach to assessment which is unfortunately not optimally practiced. Consequently, there are calls for a deliberate shift from assessment that relies exclusively on tests and formal assessments for grading and promotion purposes, towards assessment that is developmental as well as diagnostic in nature, such as formative assessment.

2.2.1. The distinction between summative and formative assessment

The national curriculum policy (DoE, 2011a) refers to formative assessment as "Assessment for Learning" (AfL) and summative assessment as "Assessment of Learning" (AoL). These terminologies highlight the purpose of each assessment type and will be used interchangeably in the study. While formative and summative assessments consist of distinctive purposes, it does not mean that these purposes are disconnected. Formative and summative assessments are not mutually exclusive but are complementary approaches used to enhance the learning experience (Dolin, Black, Harlen, & Tiberghien, 2018).

According to the DBE (previously DoE) policy, formal (summative) and informal (formative) assessment are described as follows:

> "Formal assessments (Summative) refers to tasks marked and formally recorded by the teacher for progression and certification purposes. Formal assessments provide teachers with a systematic way of evaluating how well learners are progressing in a grade and in a particular subject. Teachers must ensure that assessment criteria are very clear to the learners before the assessment process. Feedback is provided to learners after the assessment (DoE, 2011b: 3)
>
> Informal assessment (formative) refers to the frequent, interactive assessment of learners' progress and understanding, to identify learners' needs and to adapt instruction accordingly. It is used to provide feedback to the learners and teachers, close the gaps in learners' knowledge and skills and improve teaching. The written tests in the foundation phase are often inadequate as it "seldom provides enough information to the teacher to enable her to discover the reasons behind learners' errors" (DoE, 2011b: 26).

Based on the policy descriptions, formative assessment is distinct in four ways. First, formative assessment involves the interaction of teacher and learners in assessing learning. Second, formative assessment occurs when there is an intention to help learners improve their learning by focusing on the individual needs of learners. Thirdly, based on the information, the instruction is adjusted to meet learner's needs. A fourth observation is that feedback is given to learners during the learning process. The teacher has a fundamental role in supporting learner's learning through the provision of planned formative assessment opportunities at different points in their learning. Since the focus of the study is on formative assessment, this concept will be explored further in the section on the concept of formative assessment with reference to relevant literature. But it is sufficient to state here that the ideal is to have a balance between summative and formative assessment.

Summative assessment involves judging, describing, recording and reporting learners' outcomes such as their knowledge, skills, and values at a particular point in time to relevant stakeholders. It can also be used for the purpose of certification and grading, and to compare judgments of outcomes at different times of the year. The summative use of assessment is further described as being "internal administered by the schools" or "externally mandated" to the community of the school (Brown, Chaudhry, & Dhamija, 2015). The "internal' use includes regular grading for recording and reporting purposes. The "external" uses include the monitoring of the schools' "performance and school accountability, based on the results of externally created tests and assessments" (Brown, et al., 2015:87). There has been much controversy about the use of the external assessment results. It is through an assessment that educational stakeholders seek to establish how well learners are learning and whether learners and schools are progressing towards the established goals of the educational system (Pellegrino, 2003). The summative use of tests for accountability purposes has been reported to adversely affect the status of the teachers, the schools and subsequently learning (Black & Wiliam, 1998; Shepard, 1991; Stiggins, 2010). Teachers tend to teach to the test, focus solely on the content of the tests, and tend to adopt transmissive styles of teaching using procedural approaches.

This limits teachers' opportunity to use the assessment evidence formatively to support learners' learning (Kim, 2017). While the focus in this study is on research in selected schools in Gauteng, I found it pertinent to examine briefly the state of current assessment practices within the context of the South African foundation phase classrooms, drawing from empirical studies as discussed in the following section.

2.2.2. Assessment in foundation phase classrooms: A South African perspective

In South African classrooms, teaching and assessment are regulated by the National Curriculum and Assessment Policy Statements (CAPS) for each approved school subject (DoE, 2011a); the National policy pertaining to the programme and promotion requirements of the National Curriculum Statement Grades R – 12 (DoE, 2011b); and the National Protocol for Assessment Grades R -12 (DoE, 2011c). Although the assessment policies (DoE, 2011b, c, d) legitimises both summative and formative assessments and emphasises the use of continuous assessment (CA), the continuous nature of assessment is seldom practiced in classrooms (Chisholm & Wildeman, 2013; Kanjee, 2013; Kanjee & Sayed, 2013; Vandeyar & Killen, 2007) which could be attributed to various reasons.

The first reason is the "tension between formative assessment and high stakes summative assessment to hold schools accountable for learner achievement" (Kanjee & Sayed, 2013). The pressures to perform well in the Annual National Assessments (ANA) resulted in teachers 'teaching to the test' to meet the performance goal of excelling in tests at the expense of learning outcomes (learning for conceptual understanding). The ANAs were often used to hold schools accountable for meeting standards, and have had consequences for low or underperforming schools as these schools become targets for intervention until they were suspended.

The second reason is teachers' weak understanding of formative assessment. This finding is supported in a study which showed that foundation phase teachers demonstrated below "basic level" understanding of formative assessment (Kanjee & Sayed, 2013:464) resulting from ineffective teacher training and professional development on formative assessments. In the same study, it was noted that parental pressure also influences the way teachers teach, as teachers feel that they have to prove to parents that they are preparing the learners to pass the assessments in order to progress to the next grade. Killen and Vandeyar (2003) pointed out that the underutilisation of continuous assessment can be attributed to the fact that teacher training underprepared teachers for continuous assessment. Most of the teacher training on assessment focused on administrative issues such as complete government mandated forms.

The third reason is that the curriculum policies tend to promote summative use of the assessment as the policy by privileging formal testing over informal assessments (Kanjee & Sayed, 2013. The discourse of reporting and recording is greater than a discourse of using the assessment to improve learning and teaching (Kanjee & Sayed, 2013: 465). These scholars observed that the national curriculum policy (DoE, 2011a) does not provide adequate details on the tools and techniques to be applied in enacting formative assessment (Kanjee & Sayed, 2013), yet the policy provides structured guidelines on summative assessment by stipulating the number of formal tasks per term in each subject, recording procedures and reporting protocols. The fourth reason is that teachers seldom used the assessment policy and therefore teachers experience a blurred understanding of the distinction between formative and summative assessment and its requirements as documented in the National Curriculum Policy (Sethusha, 2012).

I therefore contend that the perceived tension between formative assessments and summative assessments in the foundation phase classrooms may be a possible reason for teachers' under-utilisation of formative assessment practices. I argue there needs to be a shift in emphasis from summative assessment which is used by authorities to measure whether "standards" are maintained, towards formative assessment. I concur with Rowntree (2015) that if the purpose of assessment is to improve learning, then it implies that assessment has to be diagnostic and has to take into account learner' differences. The potential value of assessing learners by interpreting incorrect answers, procedures, and processes used by learners to arrive at solutions are considered to be most significant in improving learning (Black, 2015; Ginsburg, 2009).

This is possible through a formative assessment which provides an understanding of how learners think so that appropriate follow-upand support for learners may be designed and provided" (Wiliam & Thompson, 2017: 143).

On the contrary, summative assessments which are currently driving instruction in classrooms has for long been regarded as measures to pressurise teachers to follow rigid guidelines which hamper effective teaching.

2.3. FORMATIVE ASSESSMENT AS A PEDAGOGICAL TOOL

While researchers in mathematics are primarily concerned with tools, methods, and strategies to facilitate effective instructional practices, scholars such as Beesley, Clark, Dempsey and Tweed (2018); Brookhart (2007); Clark (2015) and Wiliam and Leahy (2007) have explored the field of formative assessment as a potential tool in mediating mathematics learning as an inherent part of everyday pedagogy. Beesley et al (2018) remind us that the traditional pedagogical tools such as textbooks, workbooks, and worksheets on its own are inadequate in helping learners achieve the outcomes as it emphasises the technical content of subject matter which in many cases does not respond to learners' needs. Based on my experience and regular contact with teachers, I observed that many teachers rely on scripted lessons, textbooks and worksheets when teaching mathematics, thereby limiting formative assessment to identify learners' needs. I, therefore, concur with the claims advanced by Burton, Silver, Mills, Audric, Strutchens and Petit (2018) that formative assessment must be integrated into the planning of lessons to complement the effective use of resources.

2.3.1. The concept of formative assessment

I borrowed the term "conception' from Black and Wiliam (2009: 2) to explain formative assessment since there seems to be no single, universal, exclusive, widely accepted definition of formative assessment in the literature. Wiliam and Leahy (2007) argue that a single "gold- standard" definition of formative assessment is inappropriate as it will then necessitate the production of a set of standardised tasks which is diametrically opposed to formative assessment. The suggestion for a conceptual understanding of formative assessment is further supported by Clark (2015:105) claiming that it exemplifies the "artful process as opposed to a scientific process". Given the diverse socio-economic context in which many schools across South Africa are located, I argue that the conception of teaching as an art, let alone formative assessment, is most relevant in responding creatively and flexible to address the diverse needs of learners.

Several scholars (Black & Wiliam, 2009; Brookhart, 2018; Dolin et al., 2018; Wiliam & Thompson, 2017) remind us that formative assessment is not a new phenomenon. In the earlier years, Michael Scriven (1967:41) referred to formative assessment as being an "on-going improvement of the curriculum" while Benjamin Bloom (1969) related it to formative evaluation which referred short classroom tests used by both teachers and learners, not for grading purpose but for supporting each stage of the learning process through feedback. These definitions have evolved and over recent years with formative assessment been referred to as Assessment for Learning (AfL).

Formative assessment has gained increased attention, most notably with Black and Wiliam (1998) who described it as "encompassing all those activities undertaken by the teacher, and/or by their students, which provides information to be used as feedback to modify the teaching and learning activities in which they are engaged". Subsequently, Cowie and Bell (1999) refined this definition to indicate that formative assessment occurs during the process of learning, defining it as "the process used by teachers and students to recognise and respond to student learning in order to enhance that learning, during the learning process". I draw largely on Black and Wiliam's (2009) conception of formative assessment as the focus of my study is teachers' classroom practice of formative assessment:

> "Practice in a classroom is formative to the extent that evidence about student achievement 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 & Wiliam, 2009: 9).

Whichever way formative assessment is defined, there is however a multitude of research (Black & Wiliam, 2009; Cowie & Bell,1999; Harlen, 2007, Stiggins, 2010) that recognises it as a powerful pedagogical tool in raising students' performance. In a meta-analytical study, Wiliam (2011) found that the use of assessment to inform instruction doubled the speed of learning.

2.3.2. The theory of formative assessment

I consider Black and Wiliam's (2009) theory of formative assessment pertinent to this study as the theory was conceptualised on data obtained from classroom observations as well as teacher interviews and are, therefore, most appropriate in understanding teacher's classroom practice. Furthermore, the theory has been refined from several earlier theories and includes a theoretical basis underpinned by relevant pedagogical theories. The basis for theoretical underpinnings was motivated by scholars such as Perrenoud (1998: 89) in their review of earlier theories, arguing that theoretical models of learning "constitute the real systems of thought and action, in which feedback is only one element".

Black and Wiliam (2009) argue that teaching and learning is the joint responsibility of the teacher, the learner, and the learners' peers. They, therefore, propose a shift from the traditional role of the teacher who was in control of the learning process, to an interactive role involving the teacher, the learner and the learners' peers in every teaching and learning episode. The teacher has a crucial role in creating a conducive environment in which the learners can learn. In connecting the process of assessment, teaching and learning with the different agents (teacher, learner, and peer), Black and Wiliam (2009:23) proposed a formative assessment framework with the following five key strategies which are inextricably linked towards achieving the learning goals/ outcomes:

- Clarifying and sharing learning intentions and criteria for success.
- Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding.
- Providing feedback that moves learners forward.
- Activating students as instructional resources for one another.
- Activating students as the owners of their own learning.

The enactment of these five strategies is analysed within a framework derived from Cultural Historical Activity Theory (CHAT). Black and Wiliam (2009) identified the classroom as an activity system for analysing formative assessment activity. Hence, in 2009, Black and Wiliam formulated a theoretical [conceptual] theory on formative Assessment and hailed by many scholars as a key and seminal work on formative assessment to date. In their conceptual framework on formative assessment, Black and

Wiliam (2009) draw on the work of a number of scholars such as Boekaerts and Corno, (2005); Chaiklin, (2003); Clark (2001); Hodgen and Marshall (2005); Ramaprasad (1983) and Shulman (2005); to name a few. Black and Wiliam's (2009: 9) proposed a framework of formative assessment.

The framework is underpinned by four themes as illustrated in Figure 2.2.

- Communication and contingency.
- Teachers, learners, and the subject discipline.
- Teacher's role and the regulation of learning.
- Feedback tactics.

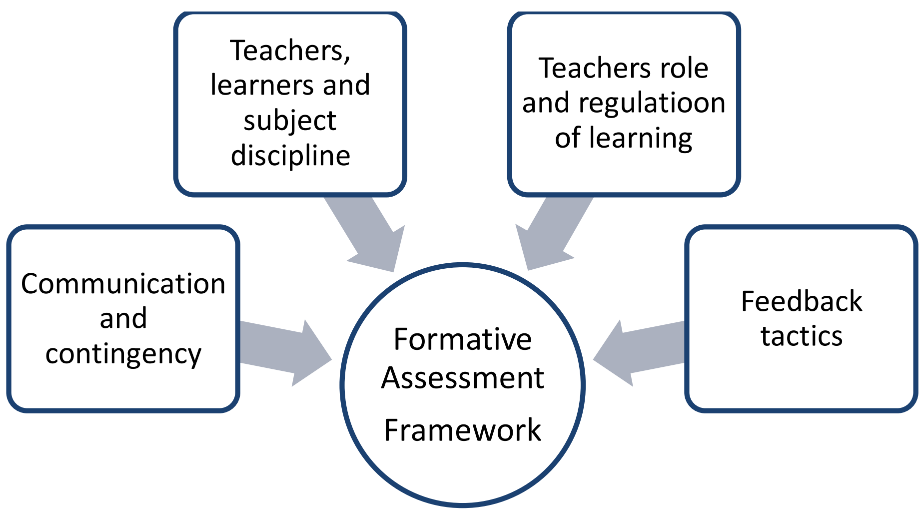


Figure 2.2: Black and Wiliam's (2009) conceptual framework of formative assessment Adapted from Black and Wiliam (2009: 5-31)

Black and Wiliam (2009) identified the following components as essential features of the formative assessment activity which are effectively explored within the activity system of the classroom, namely: Teachers, learners, and the subject discipline; the teacher's role and the regulation of learning; feedback and the student-teacher interaction and the learner's role in learning. The involvement of learners and their peers was incorporated in Thompson and Wiliam (2008) conceptualisation of formative assessment as involving three processes, namely identifying where learners are in their learning, where they are going and how to get there as shown in Figure 2.3.

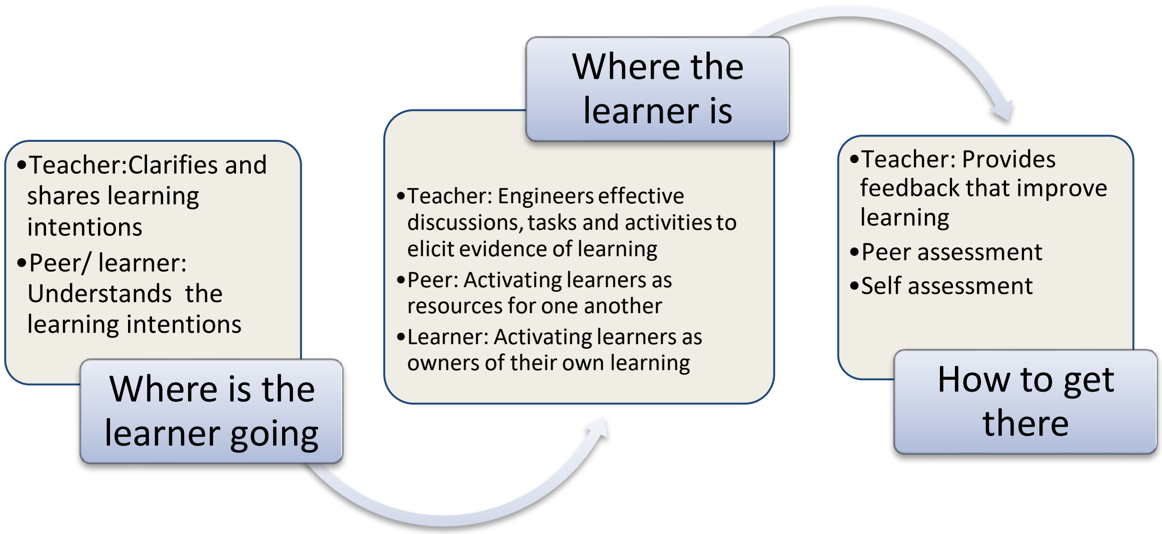


Figure 2.3: Strategies of formative assessment: (Adapted from Wiliam & Thompson, 2008:89)

The formative assessment strategies noted in Figure 2.3 can operate either individually or collectively in regulating the learning process. Black and Wiliam (2009: 12) remind us that formative assessment involves the "creation of and capitalisation upon moments of contingency in instruction" to regulate learning. In addition, these scholars contend that any attempt at facilitating a learning process requires an understanding of the intended outcome or goal of the learning. The role of the teacher is then to generate evidence of learner's learning, and to take appropriate actions to guide the learner towards achieving the intended goal. The role of the peer is similar to that of the teacher.

This process often results in power relations between peers or between the teacher and the learners. To some learners, the instructional strategies used by peers may be experienced as being more insightful than those used by teachers. The strategy of "activating learners as owners of their own learning" draws on aspects of metacognition, motivation and self- regulated learning which targets affect, cognition and actions (Wiliam, 2011). William (2011) opines that in view of learning being unpredictable, ongoing assessment at various stages of learning is essential to make adaptive adjustments to instruction. At the same time, the assessment process also impacts on the learner's willingness, capacity and desire to learn (Harlen & Deakin - Crick, 2003). For assessment to support learning, it must provide direction about the learning and must guide the learner to direct their efforts towards growth. In order to understand how the components of the concept of formative assessment are operationalised within the classroom, it requires a distinction between formative assessment activities and the occurrences of the other instructional classroom practices. In the section that follows, I make this distinction by explaining what constitutes a formative assessment episode.

2.3.3 Identifying a formative assessment episode

I drew on the work of scholars such as Bell and Cowie (2001); Heritage (2010); Mavrommatis (1997); and O'Brien (2013) who described and referred to the concept of "assessment episodes" in their analysis of classroom practices. Mavrommatis (1997) identified the following four iterative steps of an assessment episode:

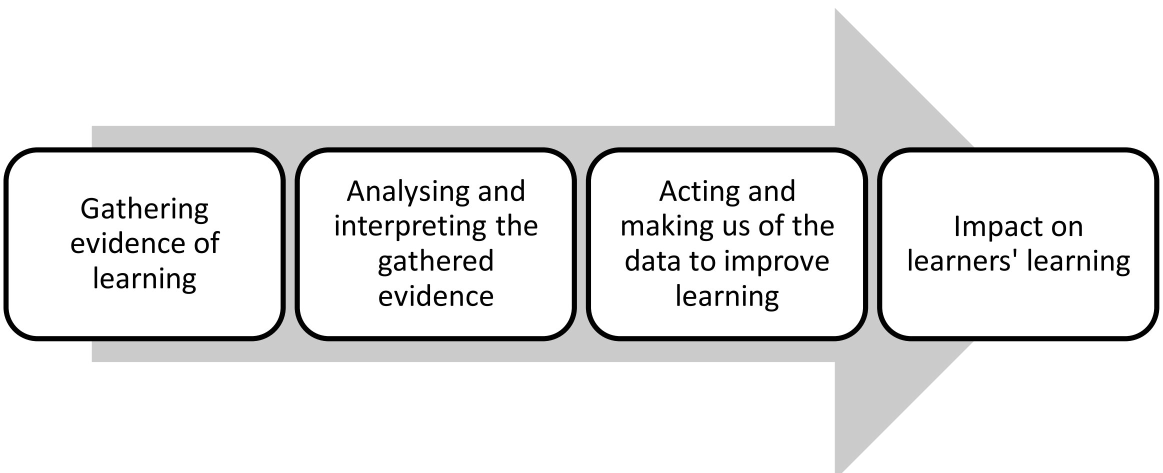


Figure 2.4: Steps of an assessment episode. Adapted from Mavrommatis (1997:90)

These steps seem to parallel the components of assessment episodes as outlined by Bell and Cowie (2001): gathering evidence of learning, analysing and interpreting the gathered evidence, making use of the data to improve learning. Having considered various descriptions of what constitutes an assessment episode, I decided to adopt the description proposed by 0xenford O'Brien et al. (2013: 38) as they add a reference parameter to the description by including the identification of learning targets and clarifying it with learners. It was also important for both the teacher and the learner to be jointly responsible for improving learning. Hence, I looked for the following activities, namely clarifying learning outcomes, collecting evidence, analysing data, interpreting data and using the data to improve instruction (See Figure 2.4 below) to identify an assessment episode.

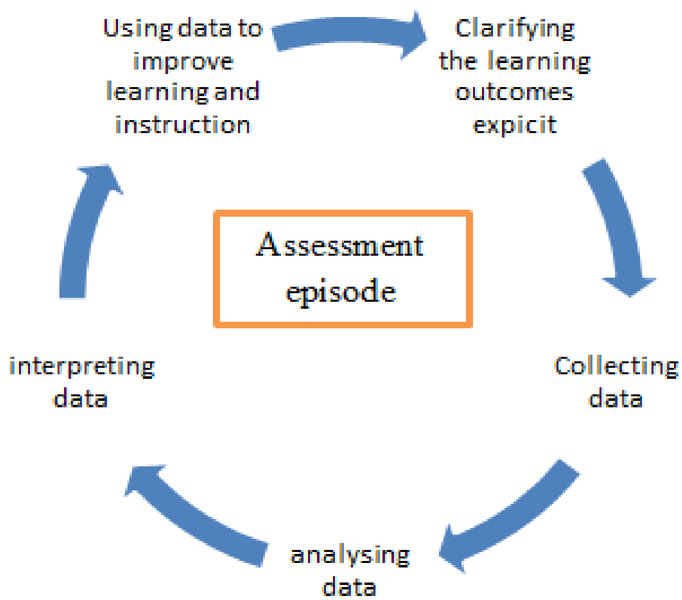


Figure 2.5: Components of an assessment episode

2.4. EMPIRICAL STUDIES ON FORMATIVE ASSESSMENT

Recent developments in the field of improving learning have led to a renewed interest in classroom assessment, specifically focusing on formative assessment. While some studies investigated the implementation of formative assessment, there were other studies that investigated the operationalisation of key components of formative assessment such as feedback, self and peer assessment, questioning and learner engagement in promoting learning.

2.4.1. Research on the implementation of formative assessment and learners' learning

Assessment researchers and experts from many countries have made radical claims that effective implementation of AfL strategies contributes to improved learning (Black, et al., 2003; Earl 2012; Popham, 2016). Black and Wiliam (1998:137) in their review of the literature found that "students taught by teachers who used assessment for learning achieved in six or seven months what would otherwise have taken a year". The improved learning appeared to be similar across other countries (Canada, Portugal, England and the United States), as well as across varied age and subjects. In addition, scholars such as Leahy et al., (2005) cited that these learning gains in achievement had long-term benefits and also showed improvement in the students' achievement with external standardised tests. Alternately, research on the implementation of AfL strategies has shown that it is beset with problems and implementation appears to be superficial in many classrooms (Marshall & Drummond 2006; Stobart, 2008; Swaffield, 2011; Torrance, 2011). Vlachou (2015:102) observed that teachers tend to "apply AfL strategies and practices mechanistically, without understanding their purpose and the cognitive principles behind them". Marshall and Drummond (2006) describe the classroom practices of the technical application of AfL techniques and procedures as reflecting the "letter" of AfL rather than the "spirit," which would make learning explicit and promote learning autonomy. Similarly, Wiliam (2011) observed that teachers were able to use AfL strategies to collect evidence of learners learning, but they seldom adjusted their teaching. The following reasons were cited by Black and Wiliam (2009: 111) as major causes for teachers' under utilisation of formative assessment:

- Classroom evaluation practices are dominated by superficial and rote learning.
- Formative assessment practices emphasised memory recall of incoherent details and knowledge items which learners forget easily.
- Lack of reflective practice as teachers seldom think critically about what is being assessed.
- The over-emphasis on the scoring aspect of assessment for the purpose of grading in relation to the developmental function of learning.
- The use of normative rather than criterion-referenced approaches to assessment employed by teachers.
- Other practical difficulties teachers encounter in collecting and recording evidence in the midst of all other demands of everyday teaching.
- Challenges experienced by teachers in adapting, repeating or differentiating instruction to respond to learning needs identified in the assessment evidence.

In one specific study on the enactment of assessment in Britain, Black (2009a:112) noted that "…even though the National Curriculum in England and Wales prescribed teacher assessment as one of the critical policy requirements, many teachers did not optimally utilise it because of their misunderstandings around formative assessment". Teachers displayed a poor understanding of the principles of the AfL procedures and the theoretical underpinnings of AfL and how it relates to pedagogy and effective learning

(Black & Wiliam, 2010; James, 2006; Stobart, 2008). Formative assessment was implemented similarly to summative assessment as many teachers collected voluminous records of learners' work but had no clear strategies on how to use these records (McCallum, Hargreaves & Gipps, 2000). In other instances, some teachers interpreted formative assessment as having to set formal assessment tasks similar to external assessments.

It is evident in the literature that the formative assessment is a complex process and hence the implementation of formative assessment requires a flexible, innovative and agile strategy. In South Africa, there were limited studies that investigated teachers' classroom practices of formative assessment. Perry (2013) has observed that there is a general uptake of formative assessment practices in the school settings as an increasing number of African countries and their agencies begin to promote the enactment of formative assessment in both primary and secondary schools. Perry (2013) cites the meta-analytical study conducted by Greaney and Kellaghan (2004) wherein they analysed assessment practices in 14 African countries.

Greaney and Kellaghan (2004) concluded that policies within these fourteen African countries "rarely emphasised classroom assessment but instead focused on summative assessments such as examinations". This observation holds true for the South African basic school education landscape where assessment practices of most teachers in South African public schools are primarily focused on summative assessment in order to meet bureaucratic requirements for progression of learners.

2.4.2. Studies investigating components of formative assessment

All five components of Black and Wiliam's (2009) formative assessment framework as mentioned in section 2.3.3 is integral to the formative assessment process and therefore needs to be operationalised in relation to one another, instead of separate entities. It is however worrisome, that there are some teachers who have the misconception that formative assessment is about implementing any of the components and view these components as being unrelated to each other (Brookhart, Moss & Long, 2010)

2.4.3. Learning outcomes and assessment criteria as mediating tools

The literature underscores the importance of learners' understanding of the learning outcomes and assessment criteria citing the development of learners' self-monitoring skills (Brookhart, 2018), their learning success (Black, 2007; Harlen, 2007) and the successful completion of task (Brookhart, 2007; Harlen, 2007; Torrance & Pryor, 1998). Learners often perform poorly because they do not fully understand what the task expect of them (Black & Wiliam, 1998). Studies conducted by Leahy et al. (2005: 23) showed that although teachers tried to make the objectives of the lessons explicit to learners, it was "rarely successful as the standards were not communicated in a "student-friendly language". This finding is supported in studies Kirton, Hallam, Peffers, Robertson & Stobart (2007) which showed a positive correlation between learners' knowledge of assessment criteria and their success at the task.

In another study, the findings showed that learners who demonstrated a sound understanding of the assessment criteria were motivated, confident and could work independently as they were able to self-evaluate and self-correct their own work (Harlen & James, 1997). The ineffective mediation of the criteria for learners was identified as one of the major challenges. Studies by Dargusch (2014) showed that teachers lack the requisite assessment literacy to mediate the criteria hence making the original criteria and standards inaccessible to learners. Similar findings were observed by Pryor and Crossouard (2008) indicating that teachers tend to redesign the criteria narrowly, making them too specific, and in so doing, they limit learners from negotiating and interpreting the criteria which are needed to develop learners' metacognitive skills. In another study, the findings showed that teachers used the criteria as a "rubric" which limited their teaching to the criteria, rather than using the success criteria to mediate learning to achieve the learning outcomes (Elwood & Klenowski, 2002: 252). This finding could be attributed to various reasons such as teachers' poor assessment literacy together with poor subject matter knowledge. Scholars such as Birenhaum, De Luca, Earl, Heritage, Klenowski, Looney Wyatt- Smith (2015) suggest that success criteria be shared with learners not only at the start of the lesson but throughout the lesson. Communicating the success criteria at the beginning of the lessons will help learners to know how they will be assessed (Bennett, 2011) and if it is communicated throughout the lesson, it will help both learners to stay focused on what needs to be achieved (Black & Wiliam, 2009). Swaffield (2011) suggests that showing learner's exemplars of tasks and comparing exemplars helps to promote learners' understanding of the success criteria.

2.4.4. Discussions, tasks, and activities to elicit evidence of learners' mathematical thinking

Assessment is integral to teaching and learning as it is important for teachers to pay attention to learners' mathematical thinking and to act accordingly (Suurtamm, 2015). Assessment should therefore be integrated into all aspects of teaching and learning in a seamless manner to inform instructional decisions to promote learners' learning. Leahy et al. (2005: 35) posit that learners' learning is supported when the "moment-by-moment actions and decisions that teachers make during teaching are informed by evidence of learners' understanding". However, these actions and decisions require focused attention in order to make learners' mathematical thinking and understanding visible. Many strategies can be used by teachers' to elicit and listen to learners' thinking, such as observations during problem-solving, informal discussions during class, or using focused questions during mathematical discussions. These methods allow teachers to be responsive to learners' understandings and adjust instruction as well as deal with particular understandings with individual learners.

Assessment can be characterised as questioning, listening and responding to learners' thinking in order to help learners advance in their thinking (Suurtamm, 2010). Suurtamm (2015) suggests that opportunities to elicit learners' thinking can be incorporated into lessons, even in the planning stages. This could be done ahead of time as teachers think of the kinds of questions that could be asked to make learners' thinking visible. The focus on attending to learners' thinking appears in many ways in the mathematics classroom. One area of focus as highlighted by Jacobs, Lamb and Philipp, (2010:169) is called "professional noticing" which can be defined as "attending to children's strategies, interpreting children's understandings, and deciding how to respond on the basis of children's understandings". Similarly, Silver and Smith (2015) suggest that formative assessment is embedded in Smith and Stein's (2011) five practices for facilitating mathematical discussions; anticipating, monitoring, selecting, sequencing and connecting. These practices encourage teachers to pay close attention to learners' thinking and to respond appropriately to that thinking, which are sound formative assessment practices. The importance of dialogical interactions to stimulate mathematical thinking was highlighted by Sfard, Nescher, Streefland, Cobb, and Mason (1998) who claimed that the communicative process is powerful in promoting mathematical meaning. This view was also supported by Streefland (cited in Sfard, 2009:28) that "mathematical discourse needs to allow for meta-cognitive shifts".

More recently, several scholars (Davies & Walker, 2007; Lee, 2012; Webb & Jones, 2009) noted the value of questions as tools used to understand childrens' reasoning and thinking. Lee (2012:15) refers to this as "*thinking conversations"* and explained that the purpose is not to find out what children know or have learned or given them information, but rather "to elicit information on their thinking" (Lee, 2012: 7). Leahy et al. (2005) noted that while a considerable amount of teaching time is spent by teachers on whole class discussions and question and answer sessions, most of the sessions tend to rehearse existing knowledge rather than create new knowledge for learners. Levin and Long (1981) found that although teachers ask 300 to 400 questions a day in the classroom, most of the questions are irrelevant as they do not stimulate learners' thinking. This finding was further supported in a meta-analytical study by Cotton (2000) which showed that far too few higher order questions are asked in class. Approximately 60% of the questions were lower order, 20% are of higher order and 20% were procedural. These questions were categorised according to Bloom's revised taxonomy (Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich & Wittrock; 2001) which categorises questions according to cognitive demands. This taxonomy includes six levels of cognition which are hierarchical from the lowest level of cognition to the highest level as follows: remembering, understanding, applying, analysing, evaluating, and creating.

Research also highlighted questioning strategies such as wait time and hands up strategy as impacting on learning. Studies have shown that teachers often ask learners who raise their hands to answer, leaving the other learners behind (Webb & Jones, 2009). In order to maximise learner participation, teachers should direct questions to the whole class, and allow sufficient time for all learners to think about the answers (Fisher, 2015). Askew (2012) found that increasing wait time to around three seconds can significantly improve the involvement of learners in classroom activities.

This finding was supported by Davies and Walker (2007) who observed that teachers ask learners who they think will give the correct answers because teachers use the learners' response to evaluate their own teaching. Teachers who use the learners' responses evaluatively assess learners based on what they have been taught. Davies and Walker (2007) argue that interpretive listening is much more beneficial as incorrect answers provide opportunities for discussions and provide insight into what learners are thinking. Walsh and Sattes (2016) highlighted the strong positive correlation between learning outcomes and wait time.

2.4.5. Self and peer assessment

The literature indicated that as learners engage in self and peer assessment their understanding of assessment criteria improved, they were able to identify their learning needs which increased their motivation to learn (Black & Wiliam, 2006; Earl & Katz, 2006; Popham, 2008). As learners engage in "self and peer assessment, they develop a shared understanding of their current learning and what they need to do to advance in their learning" (Sadler, 1989:185). This practice promotes metacognition as learners begin to reflect on their learning (Heritage, 2007). Popham (2008) noted that when learners engage in self and peer assessment, they develop critical cognitive skills, which helps them to reflect on their own learning as they adapt their learning strategies to meet their own needs. Studies by Anderson, Boud, and Sampson (2014) found that peer assessment encouraged learners to revise their own work and helped them to incorporate new understanding. It also gave learners a chance to demonstrate what they were capable of doing and helped them realise what they have not learned. While the benefits of self and peer assessment has been highlighted by several researchers, Topping (2018) reminds us that self and peer assessment is not always easy to practice as it demands specific skills and knowledge for learners to engage meaningfully. Studies by Edwards (2013) on the other hand showed that teachers too have difficulties in engaging learners in self and peer assessment. A possible reason could be attributed to teachers' difficulties in explaining the learning outcomes to learners as reported in studies by Topping (2018). Self and peer assessment are less effective and less likely to improve learning if learners lack an understanding of the learning outcomes and assessment criteria.

Studies by Brown, Hui, Flora, and Kennedy (2011) showed that teachers rarely promoted self and peer assessment in their classrooms because they felt that learners were too inexperienced to use them. Learners themselves felt that they as well as their peers were not confident in self and peer assessment, as they preferred to be assessed by an adult (Brown et al., 2011). Based on these findings, I argue that the ability to assess one's own and others work is a complex cognitive and social skill and requires guidance and practice that develops over time. This should start in the early years. It is therefore important for the teacher to build in instructional opportunities for learners to develop the capacity to provide appropriate feedback and make informed judgments about what counts as good work.

2.4.6. Feedback as a mediating tool

Researchers of formative assessment contend that effective feedback is a critical component of formative assessment and share a common understanding of what constitutes quality feedback (Brookhart et al. 2010; Hattie & Timperley, 2007; Hattie, 2012; Lee, 2009; Tunstall & Gipps, 1996). As noted by Lee (2009) feedback for formative assessment should provide opportunities for learners to engage in learning by analysing their work and leading to self-regulated learning. Brookhart et al. (2010) claim that good feedback leads to positive action by describing learners work against clear criteria and directing learners to focus on specific strategies for improvement. According to Tunstall and Gipps (1996) feedback is effective if it reports on learners' strengths and weaknesses and provides suggestions for improvement. Feedback motivates learners to engage in the activity (Tunstall & Gipps, 1996), improves the quality of learning (Black & Wiliam, 2006; Hattie & Timperley, 2007, Sadler, 2010) and contributes to learners' self-regulated learning (Hattie & Timperley, 2007).

In a meta-analytical study of more than 800 research studies involving more than 80 million students, Hattie (2012) concluded that the most powerful single modification that enhances achievement is feedback. Hattie (2012:34) posits that the simplest prescription for improving education must be 'dollops of feedback'. Through the lens of CHAT, Pryor and Crossouard (2008) drew attention to the power relations embedded within the formative assessment. Feedback is a co-constructing process between the teacher and the learner (Elwood, 2007) which leads to learner empowerment (Black & Wiliam, 2006), moving learners towards an equal partnership in the construction of knowledge (Sadler, 2010). The interactive nature of feedback has the potential to transform the classroom into a "community of practice", in the process of establishing its shared repertoire and processes of mutual engagement within its joint enterprise" (Heitink, Van der Kleij, Veldkamp, Schildkamp, Kippers, 2016). Pryor and Crossouard (2008) caution that the co-construction process can be limited by the division of labour, between the teacher and learner, during the assessment activity. This finding was supported by Torrance and Pryor (1998), who investigated formative assessment practices of teachers in kindergarten classrooms, and concluded that feedback served to reproduce and legitimise the teachers' power in the classroom.

Similar findings were revealed in a study of twenty secondary school Mathematics teachers where feedback produced a division of labour as teacher talk dominated the lessons (Hodgen & Wiliam, 2006). A review of national and international literature indicated that feedback is one of the most difficult areas for teachers (Lee, 2009). Lee (2009) found that teachers' feedback focused on learner's errors in the task but did not guide learners to correct the errors. Wiliam (2011) found that teachers focus more on the summative value of feedback which is intended to find out what learners have learned, rather than the formative purpose which reports on strengths and errors and provides suggestions for improvement.

From the above discussion, it is evident that the various components of formative assessment are significant in improving learning. With this in mind, the question then begs as to why many school teachers ignore or at the most downplay the role of formative assessment in classrooms.In the next section, I reviewed the literature on formative assessment within the context of mathematics pedagogy.

2.5. THE PEDAGOGY OF MATHEMATICS AND FORMATIVE ASSESSMENT

In this section, I explain what mathematical proficiency is. I then provide an overview of South African foundation phase teachers' current classroom practices in mathematics based on empirical studies and examine the role of learning progressions in formative assessment.

2.5.1. What is mathematical proficiency?

The National Research Council's Adding It Up: Helping Children Learn Mathematics describes mathematical proficiency as five interconnected strands (Kilpatrick, Swafford & Findell, 2001:27); namely "Conceptual understanding, Procedural fluency, Strategic competence, Adaptive reasoning, and Productive disposition". These five mathematical proficiency strands contribute to a mathematically proficient learner. Learners who have a conceptual understanding have a coherent knowledge of mathematics, not just isolated facts, procedures and methods. They can demonstrate a sound understanding of why a mathematical idea is important. Learners who display procedural fluency know "procedures and know when to use them, and can perform them flexibly, accurately, and efficiently" (Kilpatrick et al., 2001:10). Learners displaying strategic competency are efficient in formulating mathematical problems, representing them, and can solve problems with ease. Learners using adaptive reasoning are able to think logically about how concepts and situations connect, consider alternatives, reason correctly, and justify conclusions.

Learners with a productive disposition view mathematics as being useful, makes sense and see "themselves as effective learners and doers of mathematics" (Kilpatrick et al., 2001:13) These five strands are interwoven and interdependent and describe a set of knowledge, skills, abilities, and beliefs based on a body of research in cognitive psychology and mathematics education.Resnick and Resnick (1992: 47) allude to the difficulties teachers face in changing "an entrenched, traditional view of mathematics education and assessment that typically focuses on memorisation and procedures without connections". Thinking skills tend to be driven out of the curriculum by ever-growing demands for teaching larger and larger bodies of knowledge. The idea that knowledge must be acquired first and that its application to reasoning and problem solving can be delayed is a persistent one in educational thinking. “Hierarchies” of educational objectives, although intended to promote attention to higher order skills, paradoxically feed this belief by suggesting that knowledge acquisition is the first stage in a sequence of educational goals.

The relative ease of assessing peoples’ knowledge, as opposed to their thought processes, further feeds this tendency in educational practice (Resnick & Resnick, 1992: 48). It is common practice among most teachers to teach mathematical procedures, and being fairly confident that the lesson is successful. Although most learners can recall and demonstrate the procedures at the end of the lesson, they however tend to struggle to apply these procedures at a later time if these procedures are not repeatedly practiced. Resnick and Resnick (1992) argue that mathematical proficiency will not result from continuous procedural instruction, nor will teachers understand what kind of thinking learners engage in if teachers continue to assess only procedural knowledge. Teachers are currently more familiar with summative assessments such as tests which includes calculations and problems which are marked as correct or incorrect. However, teachers are less familiar with formative assessments which have more utility in making learners’ thinking visible. Seemingly, mathematics assessments appear to be neglecting this important this aspect. This is evident in the nationally administered mathematics asessments which generally provide teachers with indicators of where learners are at in relation to the two strands of conceptual understanding and procedural fluency.

It is imperative for teachers to understand learners’ thinking to be able to provide meaningful learning experiences. Evidence from formative assessment allows the teacher to delve beneath learners’ factual knowledge to probe their depth of understanding. Formative assessment offers evidence of learners’ learning that teachers can use to make informed decisions about the next question to ask and the next problem to assign or to determine which learners to group together for the next mathematical task.

2.5.2. Studies about South African foundation phase teachers' current classroom practices in mathematics

South African research in the area of teachers' classroom practice has focused predominantly on localised studies of learners' written work and classroom observation (Ensor et al., 2009). Studies by Schollar (2015), Simkins and Paterson (2005); Taylor (2008) and Fleisch (2008) show that the poor performance of South African learners in mathematics could be traced to the teachers' ineffective classroom practices. This view is further supported by Cohen and Hill (2000) who claimed that learners' performance in mathematics can be improved if teachers change their instructional practices from chalk and talk approach to practices that engage learners in meaningful learning.

Performativity in schools

Teaching in most schools in Gauteng are regulated by performativity regulations which take the form of setting targets for schools, administering common assessments designed by the Province and reporting on curriculum coverage which is mandatory for all priority schools. Pollard et al. (cited in Webb & Vulliamy, 2006) noted the difficulties teachers experienced in implementing policies that require teachers to implement external tests such as standardised tests and to record and report children's progress and achievement. The performativity policies are designed to "control curriculum and assessment practice while holding schools accountable" (Resnick & Resnick 1992: 23).

The Gauteng Department of Education introduced the Curriculum coverage model (CCM) which includes annual teaching plans which are used as a pacesetter. The CCM require teachers to report to the district twice a term on the curriculum coverage. Learners are also required to complete written activities in their workbooks every day. As part of their monitoring, both SMT and district officials are required to count the number of written activities in learners' books to check for compliance. In my view, enforcing daily written work is counterproductive to learning as it reduces the amount of time for practical demonstrations. I support the claims advanced by Reeves (2015) that monitoring curriculum coverage by counting the number of activities in learners' written work is a crude way of assessing coverage and has no value. I therefore argue that learners should not be forced to complete written work if they are not yet ready. It is therefore critical for the teacher to use different methods of assessment, such as observation, oral and practical to find out what learners know. Monitoring curriculum coverage has more value if the outcome measures are tracked for conceptual understanding, rather than to insist on voluminous written work. The ATPs were standardised for all schools and does not take into account the learner diversity. Studies conducted by Taylor and Moyana (2005) examining learners work in the Khanyisa baseline study, showed very limited opportunities for learners to engage in written work which presented teachers with limited opportunities to analyse learners' errors. They, therefore, suggest that written assessments should always be supported by observation and informal interviews for a realistic understanding of learners' thinking (Taylor & Moyana, 2015).

Another intervention to improve the performance of Gauteng priority schools was the Gauteng Primary Literacy and Mathematics strategy (GPLMS). The GPLMS was designed to address the concerns of teachers' unstructured classroom practices, teachers' ineffective pedagogy and the poor curriculum coverage in both mathematics and languages (Botha, 2014; Fleisch & Schöer, 2014). The aim of the GPLMS was to increase the pass rate of languages and mathematics in the Foundation phase from below 40% in 2010 to at least 60% by 2014 through improved teaching by reducing the gap between the intended and enacted curriculum. Teachers continued to use the GPLMS lesson plans even after the four year duration of the programme elapsed.

The lesson plans in the GPLMS are aligned to the Curriculum Assessment Policy Statement (DoE, 2011a). The weekly content and skills from the National policy are repackaged into core teaching routines, the pacing of the learning activities are specified by providing strict daily timeframes for the teaching of content. The rationale for embedding core teaching routines sequentially into a full lesson plan was to ensure that teachers would "improve time on task and establish new daily and weekly routines" (Fleisch & Schöer 2014: 3). However, through my experience as a subject advisor, I observed that carefully planned lessons on its own are insufficient in ensuring that learners will learn all that what we are developed in the lesson plans. My views resonate with the claims advanced by Clark (2001) that formative assessment is an essential process to support learning as it provides this link by informing the teacher whether the learners and teacher are on the right track during the learning process.

Effective formative assessment results in teachers continually adapting their instruction to meet learners' needs (Leahy et al., 2005). In addition, studies by Shalem, Steinberg, Koornhof and De Clerq (2016) revealed that the scripted lessons inhibited teacher' formative assessment practices as teachers followed the leassons rigidly irrespective of learners' needs. The study also revealed the following two key findings which could account for learners' weak mathematical understanding, namely; the knowledge level given to teachers in the lesson plans lacked detailed information on mathematics subject matter, and secondly teachers need strong subject matter knowledge to transmit the conceptual relations that underlie the teaching routines of the lesson plans.

In another study MacGillivray, Ardall, Curwen, & Palma (2004) noted that the move from teacher lead to scripted instruction has left teachers feeling powerless. MacGillivray et al. (2004) observed the tension teachers experienced by having to comply with strict adherence to the departmental mandates. The GPLMS lesson plans were intended to strengthen the implementation of the curriculum policy by allowing teachers the flexibility of adapting lessons where necessary (Fleisch & Schoor, 2014). Instead, I have observed that many teachers adhered rigidly to the lesson plans without any adaptation to their classroom context and learners' needs, resulting in many of the outcomes being unattained. I argue that in addition to teachers' lack of pedagogical content knowledge, many teachers, as well as subject advisors, lack understanding of the real intention and purpose of the scripted lessons which could account for the rigid adherence to lesson plans.

Based on the aforementioned evidence, I conclude that the dominant use of summative assessments together with and the systems to hold schools accountable in South Africa tend to undermine the importance of formative assessment. In comparison to countries such as Scotland, Wales, and Northern Ireland, the implementation of AfL was more straightforward, since these countries do not base their accountability system on published results of summative tests and assessments as noted by scholars such as Black (2013); Harlen (2012); James & Peddar, 2006). Teachers find it difficult to grapple with the tension of reconciling the demands of summative assessment and curriculum coverage which holds schools accountable with AfL principles. Hence, the pressures of accountability and curriculum coverage have forced teachers' in the opposite direction of formative assessment.

Teacher- directed versus learner-centred mathematics instruction

In their studies with selected teachers in the Western Cape, Roussouw (2010) observed that teachers' classroom practices were in direct conflict with the pedagogical requirement of policy for a learner-centred classroom. Learner-centred activities provide learners with opportunities to be actively involved in learning to generate new mathematical knowledge through solving problem, involving real-life situations (Clements & Sarama, 2015). Learner centred approach to teaching also enables learners to use multiple strategies for solving mathematics problems and to compare and contrast these strategies with other learners within the classroom (Webb & Webb, 2004).

Studies by Webb and Webb (2004); and Van Putten, Stols & Howie, (2014) revealed gaps between teachers' espoused belief about learner-centred approaches and their actual classroom practice. Morar (2000:276) found that teachers' practices of "learner-centred" pedagogy is often based on policy documents and impositions of departmental officials, rather than teachers' own understanding and beliefs. This contradiction may provide an explanation for the gap between teachers' verbalised beliefs about learner centredness and their classroom practices". Scholars such as Stols, Ono, and Rogan (2015) remind us that learner-centredness on its own cannot contribute to effective teaching. I agree with these scholars that there needs to be a balance of both teacher directed as well as learner-centred approach in mathematics teaching. A learner centred mathematics classroom is characterised by a culture of interaction between teachers and learners, in 'doing mathematics'. The teacher plays an important role in establishing and nurturing this culture. A teacher who sees mathematics as a body of knowledge which s/he has to impart to learners, will adopt transmissive ways of teaching by telling learners what to do, and how to do it. On the other hand, teachers who view mathematics as a body of knowledge that learners must actively explore, will create a learning environment that engages learners in critical thinking.

Although it is the role of the teachers to guide and direct learners' learning, it is critical for learners to become actively involved in the learning process in order to take ownership of what is being taught. Once again I argue that performativity and accountability limit teachers' innovativeness in teaching. It promotes the dominance of teacher-directed, whole-class teaching, with a focus on covering the content.

Procedural and conceptual teaching

The literature shows that most classrooms are dominated by procedural ways of teaching as opposed to conceptual teaching. Carnoy and Arends (2012) found that 77 % of the lessons that were observed required learners to recall facts, rules, and definitions or perform calculations without any connections to related concepts. In another study, which investigated Grade two learners' performance in two types of assessment, namely; the ANA and a diagnostic oral interview test developed by Wright, Clark and Tiplady (2018). Weitz and Venkat (2017) found that the learners performed better in the ANA than in the oral diagnostic assessments. This was because correct answers produced through ineffective counting strategies was accepted in the ANAs while the diagnostic test allocated lower marks for correct marks produced through inefficient ways. Weitz and Venkat (2017) expressed concern at the acceptance of inefficient counting strategies to get to the correct answer as Grade 1 and 2 teachers taught learners inefficient strategies to get correct answers instead of using effective counting strategies. Teachers tend to focus their teaching only on the content that is being tested and rely on ANA question papers which resulted in many concepts being left out in the curriculum. Weitz and Venkat's (2017) proposed that examples of abstract conception of numbers should be included in the foundation phase ANA question papers and that learners should make their thinking explicit by showing their working or strategies.

In another study, Reeves and Muller (2005) concluded that higher learning gains were achieved when learners across all levels, including the early grades were presented with tasks that demanded higher levels of cognitive engagement, and those tasks that engaged learners on the principles underlying mathematical procedures rather than on how the procedures work. The inclusion of cognitively demanding tasks demands a change in teaching cultures as teachers need more teaching time (Clements & Sarama, 2015b). Teachers tend to teach to the test using the examples of the ANA papers, instead of teaching for and to the individual in alignment with key learning outcomes. High cognitive level tasks can be scaffolded and simplified for learners based on the claim advanced by Heritage (2008) that formative assessment is an essential tool for individualisation and differentiation, and supporting deep learning for every learner no matter where they are in their learning journey. Spaull and Kotze (2015) remind us that learning is developmental and learners need to first master the subordinate skills foundational knowledge in order to understand high ordered knowledge and skills. This necessitates a specific organisation of the curriculum where the knowledge structure is sequenced in such a way that the simple concept precedes the more complex concepts.

Several studies on mathematics learning in South Africa (Askew, Venkat, & Mathews, 2012; Hoadley, 2012; Hiebert, Carpenter, Fennema, Fuson, Human, Murray, Oliver & Wearne,1996; Spaull & Kotze, 2014) have highlighted the lack of mathematical foundational knowledge and skills as factors inhibiting further learning. I argue that the lack of higher-order content in mathematics in the early Grades may be a possible reason for the limited use of formative assessment in mathematics teaching. Learners are seldom presented with challenging tasks to stimulate their thinking.

Use of manipulative and representations

Several studies have highlighted the importance of tailoring instructions to meet learners' needs (Bhatti & Bart, 2013). It is therefore important for teachers to incorporate varied teaching strategies, methods, diagrams, demonstrations, representations and manipulatives to promote learners' understanding. Representations refer to the wide variety of ways to capture an abstract mathematical concept or relationship. A mathematical representation may be visible, such as a number sentence, a display of manipulative materials, or a graph, but it may also be an internal way of seeing and thinking about a mathematical idea. Regardless of their form, representations can enhance learners' communication, reasoning, and problem-solving abilities; help them make connections among ideas; and aid them in learning new concepts and procedures.

Since representations support and extend reasoning by helping learners focus on essential features of the mathematical situation, it makes learners' thinking explicit which is essential for formative assessment. Representations give learners useful tools for building understanding, communicating information, and demonstrating reasoning. (Greeno & Hall, 1997). When learners are able to represent a problem or mathematical situation in a way that is meaningful to them, the problem or situation becomes more accessible. Using representations, whether drawings, mental images or concrete materials, helps learners organise their thinking and try various approaches that may lead to a clearer understanding and a solution. Learners' thinking and the representations that express this thinking can vary greatly, even when addressing a single idea. One learner may orally describe her interpretation of the mathematical concept or problem. Another may model it with base-ten blocks and another may draw a picture that illustrates an understanding and a solution for the problem,

Manipulatives refer to the physical and concrete materials such as cubes, dienes blocks, base ten blocks, counters and other everyday objects that help learners explore and develop an understanding of mathematical ideas and concepts (Kablan, 2016; Tulbure, 2011). White (2012) claims that a common problem is that teachers often struggle to help learners to link the materials to the concept, and to relate the mathematical representations to conceptual understanding.

Drawing on Piaget's theory, Kamii (1986: 76) posits that place value is a complex concept and therefore cannot be taught through "surface rules", about which numeral is placed in which column from the hundreds, tens and units. Kamii (1986) offers three important points to consider in teaching place value. Firstly, number concepts belong to logico-mathematical knowledge, having its source of knowledge in the child's mental activity, and not in sets of objects in external reality (Kamii, 1986). This means that teaching place value through representation or drawing can have little value unless learners are taught how to make connections. Secondly, number concept development is developmental. Children cannot construct a system of tens on a system of ones unless they can conserve the system of ones on their head into parts of tens. Thirdly, place value involves multiplication, for example, 45 means 4 times ten, and 5 more. I opine that many of the misconceptions of place value are a result of the under-utilisation of formative assessment during the process of learning.

Another problem that was observed is teachers' inefficient use of manipulatives in teaching for conceptual understanding. In the same study, Hiebert and Morris (2009) observed differences in the way teachers used the teaching materials. Teachers who used the textbook-based instruction used a range of teaching materials but for a shorter time than the alternative instruction, the teacher used the materials for a shorter time. The textbook based teachers used them more for demonstration as learners' watched whereas the alternative instruction required learners to work consistently with the materials over an extended time. In contrast learners in the textbook-based classrooms were exposed to a greater variety of material but spent less time with the material as they watched someone else demonstrate its use.

The main finding of the studies conducted by Ensor et al., (2009) showed that Learners' in Grade 3 generally depend to a large extent on concrete ways for problem-solving rather than on abstract ways. They further point out that this anomaly is the direct result of how Grade 3 learners are taught in the classroom by teachers who depend primarily on transmission modes of teaching. Ensor et al., (2009) also observed that in instances where classroom size was too large, where teachers lacked teaching resources and in instances where teachers did not understand the policy, there was a tendency for teachers to implement teaching strategies underpinned by rote learning at the expense of abstract learning.

Studies cited and analysed in the preceding sections show that curriculum pacing as prescribed by guidelines is, in fact, a barrier to effective mathematics teaching. Teachers tend to place emphasis on curriculum coverage as a tick box exercise just to meet timelines. While the GPLMS and the CCM are initiatives to support teachers in pacing their teaching to cover the content, it requires willingness on the part of teachers to adapt their teaching and assessment practices in line with these interventions. I however argue that even though teachers follow these prescriptions, teachers should be afforded some flexibility in their teaching to accommodate their innovativeness as well as unique classroom context.

2.5.3. Learning progression and formative assessment: A South African perspective

For the purposes of this study, I refer to the concept “learning progression” in keeping with the nomenclature of the National Policy Statement (DoE, 2011a) whereas literature abound referring to this very same concept as learning trajectory (Black & Wiliam, 1998; Clements & Sarama, 2015a). Black (2007), argue that effective formative assessment requires a developmental framework to measure learners’ progress in learning. Similarly, Clements and Sarama (2015a) claim that through learning progression, the teacher can accurately assess learners learning within a mathematical topic, which will, in turn, enable them to support learners to advance to the next levels of thinking. Learning progression is an important tool used in formative assessment as it offers a framework for the teacher to gauge at which level of thinking learners are operating, along with the next level of thinking which is in line with Vygotsky’ s ZPD (Heritage, 2010). The instructional tasks stated in the learning progression provide guidance as to the type of educational activity to support that learning and help explain why those activities would be effective (Heritage, 2010). This is crucial for formative assessment as it informs the teacher of the standards or goals that have to be achieved, the learners’ current knowledge and how to support learners to achieve the goal. This finding is supported in studies by Clements and Sarama (2015a) which showed that teachers’ knowledge of learning progressions in the use of formative assessment has the potential to strengthen the interpretation of evidence of learners work to inform instruction and learning.

Clements and Sarama (2015b:65) identified three key components of learning progression which is aligned with the three formative assessment questions as shown in the Figure 2.6 on the next page:

Formative assessment questions	Clement and Sarama's (2015)Learning trajectory components
Where are you going?	The goal: Describes the mathematical concepts, structures and skills
Where are you now?	The developmental progression: Helps determine how the children are thinking now and on the next step
How can you get there?	The instructional activities: Tasks are aligned to each level of developmental progression that are designed to elicit the kind of thinking that will form the next level. Provides feedback to address specific errors

Figure 2.6: Learning progression. Adapted from: Clements and Sarama (2015b:65)

From the above analysis of learning progression, I argue that the principle of progression which underpins the South African foundation phase mathematics policy (CAPS) creates a meaningful context for the enactment of formative assessment. The mathematics curriculum content is designed within two levels of “progression”, i.e. progression across the three grades in the foundation phase (presented in CAPS as phase overview) and progression within the Grade across the terms (presented as grade overviews in CAPS).

To further explicate the notion of progression, I chose to use the example of “place value” to elucidate the sequential development of the concept across the grades in the foundation phase (Figure 2.7) and within a grade with specific reference to Grade 3. Figure 2.7 illustrates an overview of the concept of place value across the foundation phase from Grade 1 to Grade 3. The concepts become increasingly more difficult across the grades (in order to promote the progression of learning).

Figure 2. 7 also shows that as learners move through the learning trajectory, learners learn to solve increasingly more difficult problems. Some problems are increasingly difficult because it involves larger numbers. Beyond the size of the number range, it is the type or structure of the problems and the calculation strategy.

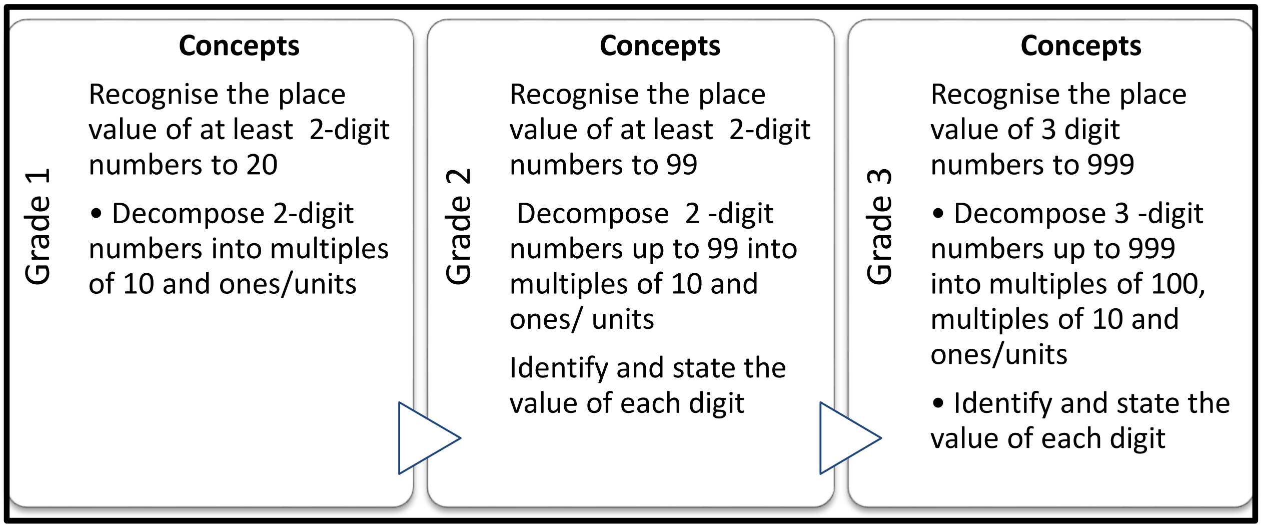


Figure 2.7: Learning progression across grades in the foundation phase – Phase overview: Development of Place Value: Extracted from DoE (2011a:20)

The notion of learning progression across the grades as evident in CAPS is also supported by Briggs and Peck (2015) who maintain that a learning progression is an essential tool in tracking learners' development across grades in the schooling system. When learning progression includes levels that span more than two grades, attention is focused on the changes in learners' understandings that would be expected to take place across both grade levels as learners are exposed to instruction targeted to certain core concepts (Briggs & Peck; 2015).

In my view, mapping progression and learning outcomes in the different grades in the foundation phase is somewhat complex as documented in CAPS (South Africa). CAPS does not take into account the context of schools, learner profiles and even teacher expertise in some instances. This contextual differences amongst school settings make it somewhat challenging teachers to support learning progression effectively, hence the teacher's ability to support learning progression through formative assessment practices are largely ignored. Given the diverse abilities of learners, particularly learners who are functioning at a lower grade level in Grade 3; it is incumbent for teachers to have a thorough knowledge of the curriculum not only within a grade but also across the phase to provide appropriate instruction at different levels.

Black and Wiliam (1998) support this contention in his claim that the task of analysing learners' responses in relation to a scheme of progress in their learning is a demanding one.

Given the hierarchical nature of mathematics, learners need to acquire an understanding of the basic knowledge and skills before moving on to the complex concepts. Identifying learners' knowledge gaps is a demanding role for teachers to decide what to assess and how to interpret learners' work. While a lack of understanding of a certain concept may be of little concern, as it will be encountered again later and until then that understanding will not be needed, a lack of understanding of other concepts, which forms the essential basis for further work, may be of serious concern and therefore requires immediate attention. If these learning difficulties are unresolved, then the learner is precluded from further learning.

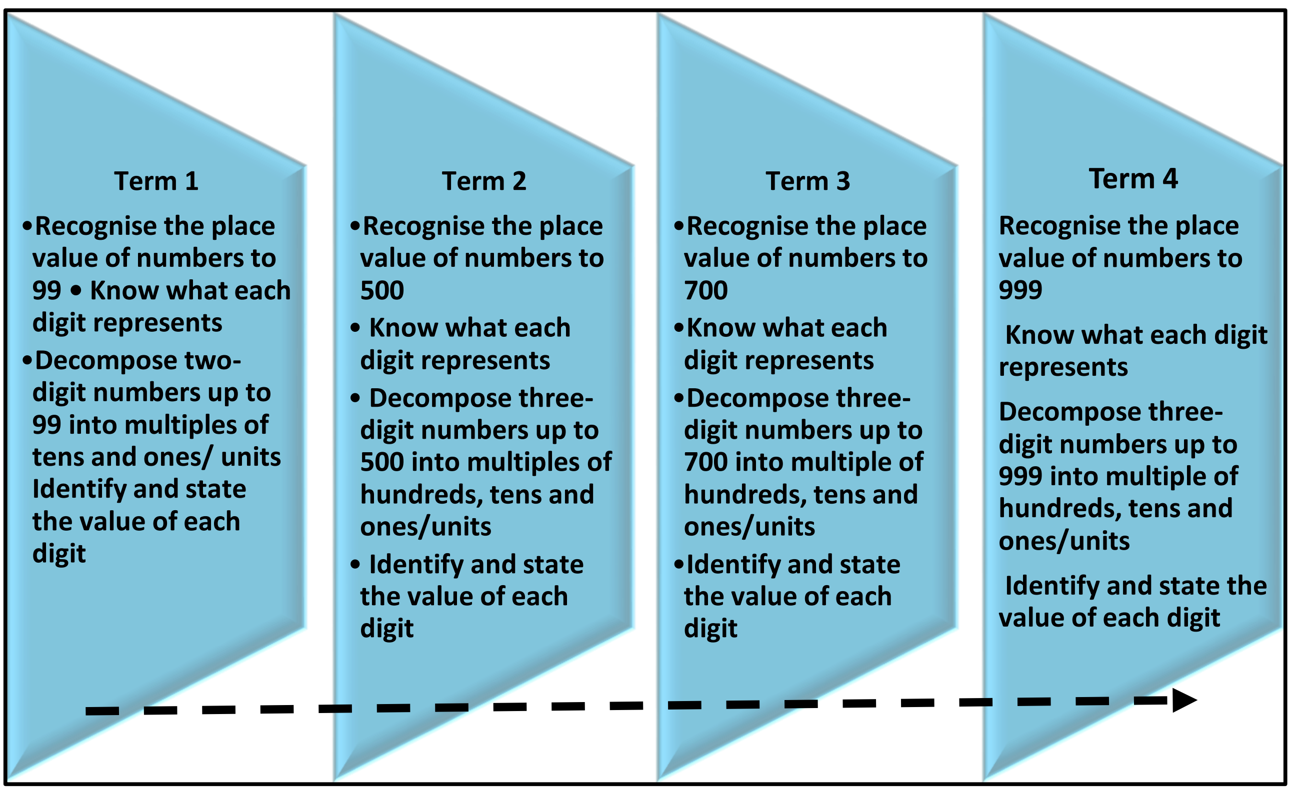


Figure 2.8: Grade 3 overview of place value across the four terms. Extracted from DoE (2011a)

Deciding between what may be left out and what has to be grasped now is often a challenge among teachers. I therefore argue that if used effectively, the national curriculum policy can serve as a powerful pedagogical tool given the sequential development of concepts within a grade and across grades by guiding teachers on how learners may progress in their learning, which is aligned to a clear conception of the curriculum and learning goals (Black & Wiliam, 1998).

Despite the potential of the CAPS policy to offer opportunities for formative assessment, it is unfortunate that formative assessment is not optimally utilized as teachers focus only on the curriculum knowledge relevant to the Grade they currently teach. It is for this reason that many learners do not advance in their learning as a learner who lacks knowledge from the previous grades are not fully supported. Rather than adapting their instruction by teaching the learners concepts from the previous grades to meet the needs of these learners, which is the purpose of formative assessment, teachers continue to keep track with the Annual teaching plans (ATPs). The ATPs is a curriculum tool that is devised by the district to help teachers pace their teaching of the content to ensure curriculum coverage. It seems that tthe rigid adherence to the ATPs have led to Grade 3 teachers' misunderstanding that it is not their responsibility to teach concepts from previous years,yet this is what formative assessment is about.

In support of the claims, advanced by Black and Wiliam (1998:26) that "formative assessment cannot simply be added as an extra to an existing, non- interactive scheme of work", I argue that teachers should be allowed the flexibility to adapt the annual teaching plans and the prepared lesson plans provided by the district to schools by integrating innovative strategies and adapting their instruction as the need arises.

2.6. TEACHERS' UNDERSTANDING OF HOW CHILDREN LEARN MATHEMATICS

Teachers' understanding of mathematics and understanding of learners' thinking plays a critical role in the teaching of mathematics. The mathematics content and the task and tools are usually specified in the curriculum, but without requisite understanding of mathematics and how learners learn, teachers will be relegated to the routine presenting someone else's ideas without adapting them for their own learners. Hence, their classrooms will be dominated by curriculum scripts, as they will not be able to establish the classroom norms necessary for learning with understanding to take place. Franke, Webb, Chan, Ing, Freund, and Battey (2009) argue that teachers' knowledge of mathematics must be linked to knowledge of learners thinking so that teachers have conceptions of typical trajectories of learners thinking and can use this knowledge to recognise landmarks in learners understanding. Carpenter, Fennema, Peterson, Chiang, and Loef (1989) pointed out that one of the critical problems facing teachers is how to apply the knowledge of children's learning and problem-solving to classroom instruction.

2.6.1. Learner diversity

Learner diversity is an important attribute to consider in mathematics teaching and formative assessment. It is unfortunate that teachers in some educational landscapes such as that in South Africa are constrained by policy guidelines which in many instances do not consider learner diversity and its linkage to curriculum pacing, curriculum coverage, assessment tasks.

Denvir and Brown, (1986:21) states that "all learners do not all learn in the same way, so teachers cannot be expected to teach all learners in the same way". Wright (2017:89) contends that "… effective planning of a curriculum, as well as effective planning of support for all learners, need to engage with realistic expectations regarding the likely variation in learning trajectories, and to encourage the development of strategies at different levels". Hence, teachers are required to review their teaching practices so as to accommodate learners with diverse profiles. In order to accomplish this, teachers must familiarise themselves with in-depth knowledge of learners' backgrounds, their level of prior knowledge and learner's ability. In this way, teachers can plan and enact formative assessment practices in a way to gather as much data as possible on "where learners are and where they need to go" (Stiggins, 2008).

Similarly, Shulman (2005) recognised the importance of teachers' understanding of how children think and how teachers to teach is a major contribution to psychology and mathematics. Scholars such as Shepherd (2013); Ginsburg (2009) and Dehaene (2011) argue that unless teachers make a concerted effort to understand how learners learn, there would be little success in improving the quality of teaching and learning in schools. I, therefore, argue that teachers' knowledge gap of not knowing how to plan according to how learners learn compromises innovation, applicability, and enactment of formative assessment.

Scholars such as Feiman-Nemser (2001); Sherin (2002) and Silver, Ghousseini, Gosen, Charalambous and Strawhun (2005) also drew conclusions from their studies, that many teachers miss out on opportunities to use learners' thinking to build on mathematical understanding mainly because teachers themselves lack an understanding of how learners learn. Teachers' lack of knowledge of how children learn could account to teachers' difficulties in identifying and interpreting the evidence of thinking displayed by learners in the classroom (Peterson & Leatham, 2009; Van Zoest, Peterson, Leatham & Stockero, 2016). These opportunities often go either unnoticed or are not acted upon by teachers, particularly less experienced teachers. Van Zoest et al. (2016) refers to these opportunities as "critical moments" (evidence) during a mathematics lesson as they have the potential to provide mathematical pedagogical opportunities that teachers can harness and build upon in so far as how learners think and learn.

However, the identification of critical moments as a source of evidence was also recognised by other scholars (Walshaw & Anthony, 2008; Davis & Walker, 2007; Schoenfeld & Kilpatrick, 2008). These scholars noted that the varying description of "critical moments" is crucial if teachers want to understand how children learners learn in order to provide appropriate intervention which is one of the purposes of formative assessment. Black and Wiliam, (2009:23) mention that it is "… essential for teachers to understand the different ways in which learners' mathematics may develop, identify key areas where learners encounter difficulties, as well as develop effective strategies for addressing these". They further mention that teachers who have the capacity to enact formative assessment innovatively, are in a stronger position to meet the needs of diverse learners. These teachers are also able to adapt and engage in differentiated teaching to accommodate learners with mixed abilities.

2.6.2. Learners' prior knowledge

Learners' prior knowledge has been singled out as a significant factor in the enactment of formative assessment. Ignorance of learners' prior knowledge will leave teachers not knowing where to pitch a lesson or how to identify learners who need help (Carpenter & Leher, 1999). Recognition of learners' prior knowledge will enable teachers to become more sensitive to the differing needs of learners so that they can adapt their teaching accordingly. This point was supported by Ausubel (1967:13) who argued that “what learners know and have learned will continue to affect what they can learn”. Hence, formative assessment plays a significant role in ascertaining learners’ prior knowledge because it focuses our attention on learners’ prior knowledge and provides us with the techniques to bring this knowledge to light (Wiliam, 2016). Assessing this knowledge involves being attuned to what learners bring to the mathematics classroom being able to actively listen to and respond to learners’ own informal strategies (Carpenter & Lehrer, 1999) and to have awareness of the mathematical knowledge that learners develop in their everyday lives (Nunes & Bryant, 2009). As part of this, teachers need knowledge of common errors and misconceptions in mathematics, which are invaluable in diagnosing the difficulties learners encounter (Dickson, Brown & Gibson 1984; Ryan & Williams, 2007). In this study, I refer to “… misconceptions as the result of an attempt to make sense of a situation, using ideas that have worked in past situations but do not adequately fit the current one (McGowen & Tall, 2010:90).

Another important tool used to understand learners’ prior knowledge is the use of analogies (Richland, Stigler & Holyoak, 2012). When learners encounter a new problem, they may draw on their existing knowledge of related problems in an attempt to solve the problem. The process of making inferences from existing knowledge is referred to as analogical reasoning (Carrol, Mack & Kellogg, 1988). Analogies are frequently used by teachers to explain complex or abstract ideas by linking new ideas to more familiar concepts (Duit, 1991; Harrison & Treagust, 2006). It does so by activating relevant prior knowledge which is already known to learners (Braasch & Goldman, 2010). While some researchers (Posner, Strike, Hewson & Gertzog, 1982) argue that analogies are used to stimulate learners thinking, Glynn, Law, and Doster (1998) caution that analogies have the potential to mislead and confuse learners. One of the reasons as advanced by Duit (1991) is that learners often do not understand the analog (the concept that is assumed to be familiar) and transfer those misunderstandings to the target concept (Duit, 1991). Studies by Brown and Clement (1989); Glynn et al. (1998); and Vendetti, Matlen, Richland & Bunge, (2015) have shown that ongoing analogical reasoning has been successful in facilitating comprehension and problem-solving. Brown and Clement (1989) claimed that in some situations the analogies did not work as learners were not able to “see” the analogy. This finding was supported by studies on students' conceptions of analogies conducted by Duit (1991) which showed that areas that seemed as obviously similar by the teacher were viewed as fundamentally different by the learners. Spiro (1988) argue for the use of multiple analogies as they may avoid misguidance caused by a single analogy.

Vendetti et al. (2015:67) remind us that the "… ability to apply knowledge from one context to another is a difficult problem, both for children and adults. Reasoning by analogy is especially challenging for learners, who must transfer in the context-rich and often high-pressure settings of classrooms". One of the difficulties identified by Richland et al. (2012:104) is that children are highly susceptible to irrelevant distraction, they often notice perceptual features instead of the relationships that are at the core of the analogy. This implies that the teacher, therefore, needs to help the learners to identify key relationships and to disregard irrelevant distractors.

This guidance can take the form of question prompts that explicitly structure the comparison process (Catrambone & Holyoak, 1989) or of visual aids (Richland & McDonough, 2010). Vendetti et al. (2015) contend that engaging learners in several analogies can afford powerful cognitive benefits on learning. Being able to gather information by making analogical comparisons, along with understanding when certain inferences may not transfer between examples, is an important part of critical thinking that can be applied in a diverse range of educational disciplines. As pointed out by Richland, Morrison, and Holyoak (2006), that the neural structures for analogical reasoning are already in place by the age 6, if not earlier, highlights the point that young children do not have a structural impediment to relational thinking. Against this background, I support the views of Vendetti et al. (2015:34) who concluded that "Children need to be guided with systematically guided experience to support the development of a strong reasoning system and promote a deep understanding of concepts. Visual supports can serve as powerful tools by providing explicit visual cues that draw attention to relational similarity".

2.6.3. The role of cognitive science in understanding how learners learn

The role of cognition is critical to understanding the minds of learners in formative assessment as noted by scholars such as Ginsburg (2009), Pellegrino et al. (2001) and Shepard (2008). Ginsburg (2009) highlights the importance and significant role that cognitive science plays in understanding children's mind and their thinking patterns. Ginsburg (2009) therefore makes a strong business case for the re- introduction of development psychology theories and its related typologies in ensuring innovative formative assessment practices in improving teaching and learning.

Ginsburg (2009) also introduces a construct which embodies three developmental trajectories:

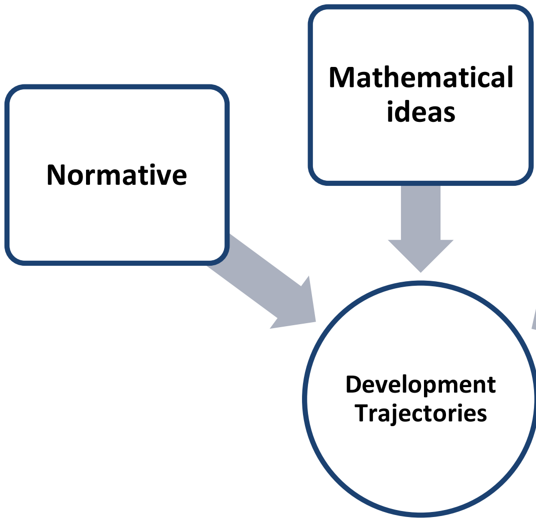


Figure 2.9: Development trajectories. Source: adapted from Ginsburg (2009)

Ginsburg (2009:8) identifies "three types of potential obstacles that stand between the child and the learning goal, and to appreciate the complexities of the child's mind". The obstacles are represented in Figure 2.10.

By incorporating cognitive theories in formative assessment practices, teachers would have the means to connect formative assessment processes that focus on identifying gaps in learning and moving learners forward (James & Pedder, 2006; Pellegrino et al., 2001; Shepard, 2008; Wilson 2008). The need to forge theories of cognition with the processes of classroom assessment and instruction is not limited to the opinions of educational and psychological researchers in the field.

During Black, Harrison, Lee, Marshall & William (2004) exploratory work to develop classroom assessment practices, participating teachers asked for sessions on the psychology of learning.

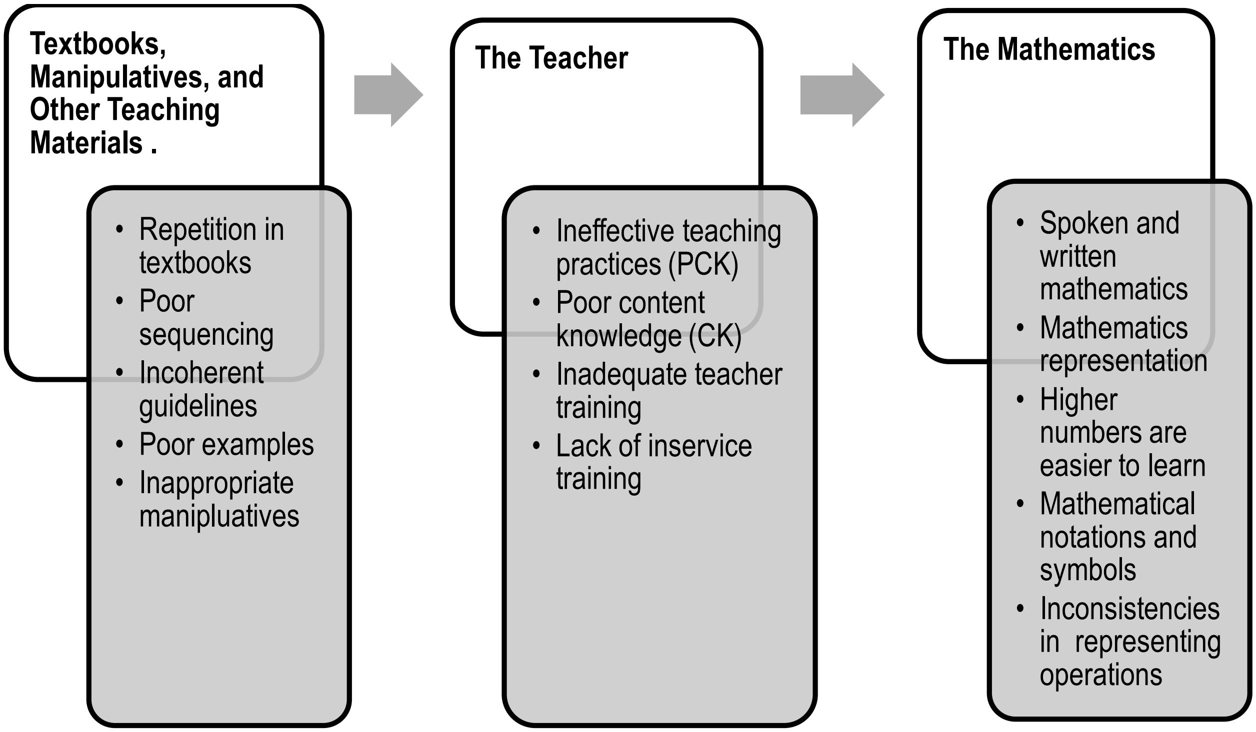


Figure 2.10: The obstacles to mathematical thinking amongst learners (Ginsburg, 2009:8)

This request was not a surprise to the authors, as they understood that teachers needed to build their own models on how students learn in order to provide feedback that would be useful to learners, thus improving their performance. Models of classroom assessment that utilize this knowledge base are rare and research is still limited on how the models work (James & Pedder, 2006).

I have also observed that cognitive theory and its science in explaining assessment appears to have taken a back seat regarding current discourses and debates in foundation phase schooling. I, therefore, argue that there is a need to take into consideration expanding perspectives on how people learn and the processes by which knowledge is acquired in subject area domains when framing formative assessment practices in the classroom. Yet, formal classroom assessment models that bring together theories from cognitive sciences, developmental psychology, and studies in pedagogy are lacking in the educational literature.

In the next section, I discuss relevant theories to explain and advance principles and strategies of how children learn mathematics. It is incumbent therefore on teachers to understand theoretical underpinnings on how children learn mathematics if they are to make a difference to enact formative assessment in early Grade mathematics classrooms.

2.7. TEACHING AND LEARNING THEORIES

Taylor and MacKenny (2008) made a compelling case for the importance of teachers understanding of learning theories if they wish to achieve success in improving instruction in the mathematics classroom through formative assessment. In their synopsis, Taylor and MacKenney (2008) pointed out three significances of learning theories that shape mathematics teaching and identified the following three importance of learning theories namely:

- learning theories provides insight into learning processes that can be understood in practice; secondly;
- learning theories provide a theoretical basis upon which advancement and additions to teaching and learning strategies are underpinned and that learning theory provides insights into the effective facilitation of learning and
- the construction of conducive learning environments in which formative assessment can be enacted to promote learning outcomes.

Hence, I chose to discuss four learning theories, namely; behaviourism, cognitivism, constructivism and socio-cultural theories, namely constructivist, behaviourist, cognitive and sociocultural perspectives. Pellegrino (2003) assert each perspective is different, hence, an understanding of each of these perspective offers differing implications for what should be assessed and how the assessment process should be transacted.

Figure 2.11 illustrates diagrammatically the learning theories chosen for analyses in this section.

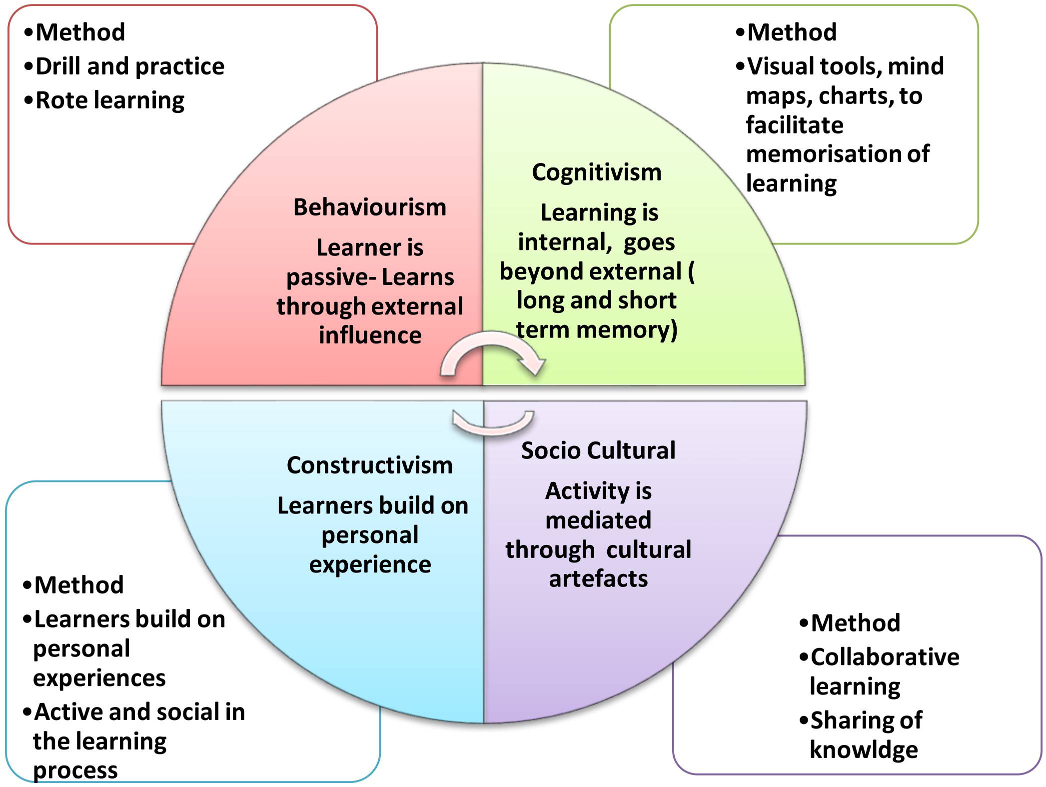


Figure 2.11: Learning theories relevant to the learning of mathematics

2.7.1. Behaviourist learning theory

Behaviourist learning theories view "learning as the conditioned response to external stimuli" (James & McCormick, 2009: 36). These theories also share the understanding that "complex wholes are assembled out of parts so learning can best be accomplished when complex performances are deconstructed and when each element is practiced, reinforced, and subsequently built upon" (Pellegrino, 2003:34). From this perspective, achievement in learning focuses on quick results on performance through the "accumulation of skills and the memorisation of information' (Pellegrino, 2003: 42). According to the behaviourist view, the teacher's role is to develop learners to respond to the teachers' instructions accordingly. According to the behaviourist view, learner achievement is usually considered as being either correct or incorrect.

Within this perspective, typical formative assessment will entail repeated practice on the incorrect items, reinforcement, drilling, rote learning, deconstructing concepts further and going back to even more basic skills in order to remediate poor performance. The behaviourist view repetition as a corrective mode in teaching and therefore favor the drill approach in learning. The content to be taught is deconstructed into and taught to learners in a logical sequence. If a child misses any components, he goes back or repeats the sequence leading to that component. The behaviourist approach to teaching is most common in current classrooms where teachers were trained during the 1960s and 70s and focused on modifying behavior (James & McCormick, 2009).

2.7.2. Constructivist learning theory

The term constructivist is used to describe learning which occurs through the "active engagement of learners and is determined by what goes on in peoples' heads" (Pellegrino, 2003:42). This view of learning led signals shift from the "knowledge-acquisition to knowledge-construction" (Pellegrino, 2003: 45). In contrast to the behaviourist who hold the view that a child can be conditioned to learn any logical steps at any stage of development, the constructivist is of the view that mental processes must be taken into account as there are stages of development in the abilities of the child to think logically or mathematically (Copeland, 2000).

The developmental nature of learning proposed by Bruner (1961: 63), namely "enactive (child manipulates materials directly), iconic (child deals with mental images of object but does not manipulate them directly), and the symbolic (manipulates symbol and no longer mental images of objects)" must be considered in instructional planning. Another distinguishing feature is that the behaviourist in interested in the acquisition of knowledge of content, subject matter or answers, while for the constructivist, subject matter knowledge, basic facts, skills or answers have little importance as they are concerned with the process of understanding the concepts or operations involved.

Regardless of the instructional approaches used, the formative assessment strategies must conform to the instructional approach used in teaching. For example, when the guided instruction approach is used, scaffold support will begin with the simple prerequisite tasks towards the achievement of the capability, whereas in the case of

Bruner's (1961) discovery approach, scaffold support will begin with the problem itself guiding the learner to move back through the hierarchy to form the needed associations and to finally derive the appropriate rules for the problem. Both Gagne (1970) and Ausubel

(1967) argue that successful teaching is dependent upon some previously attained knowledge base. This means that certain prerequisites of understanding may be necessary before effective instruction leading to cognitive re-organisation can be successful. Hence there is a strong relationship between a learner's prior knowledge and their potential and capacity to learn new knowledge.

There are two components of metacognition, namely self-monitoring and self-regulation which are the cornerstones of effective learning. More recently, "metacognition has received widespread attention for its implications for teaching and assessment" (Black & Wiliam, 2008:90 and Torrance, 2009:67). Contrary to the behaviourist view; the proponents of the constructivist hold the view that that "drill and practice will not necessarily teach the concept involved" (Torrance, 2009:69). The constructivist holds the view (Torrance, 2009:67) that to "correct errors, children must first understand the logical or mathematical concept involved by exploring the situation using physical or concrete materials".

According to the constructivist view, the role of the teacher is to provide necessary physical materials for the children and guide their thinking by asking appropriate questions. The role of prior learning as a determinant of the acquisition of new knowledge requires teachers to plan to teach episodes in accordance with what the learner already knows to what new knowledge the learner can acquire. Hence, "the element of pedagogic practice is important because it involves a process of eliciting learners' mental models through classroom dialogue, open-ended assignments, thinking- aloud protocols, concept-mapping, in order to scaffold their understanding of knowledge structures" (Black & Wiliam, 2008:99). Hence, Pellegrino (2001:102) argues that "teaching and assessment are blended seamlessly towards the goals of learning, particularly the goal of closing gaps between current understanding and the new understandings sought. It is not surprising, therefore, that many formulations of formative assessment are associated with this particular view of learning".

2.7.3. Cognitive learning theory

Cognitive theories posit that knowing means more than the accumulation of information and routine procedures; it means adapting and integrating the knowledge, skills, and procedures to interpret situations and solve problems. To this end, Pellegrino et al.

(2001:62) argue that instruction must go beyond basic information and skills, but should serve as resources for meaningful learning. From the perspective of the theory of cognitive learning, the purpose of assessment is to determine not only what learners know, but also to assess whether they are able to transfer and apply their knowledge to other situations. It is of concern that many learners struggle to transfer their learning, which could be attributed to inefficient ways of teaching that leads to superficial learning (Copeland, 2000).

Transfer of training is an essential requirement in learning. Without transfer, learners will only practice what we teach, as the span of their learning could never exceed the range of situations or problems encountered in their instruction. Gagne (1970) proposes a distinction between lateral transfer and vertical transfer. Lateral transfer refers to the manner in which the learning of a capability in one domain can facilitate the mastery of some parallel capability in another domain. Vertical transfer refers to the manner in which the learning of a subordinate capability can facilitate the mastery of subsequent learning at a higher level of the same hierarchy.

Pellegrino et al. (2001) argue for the use of formative assessment, as it is difficult to assess how, when and if learners use what they know in solving problems through traditional tests. Traditional tests focus on right or wrong answers and do not provide information on how the answer was derived and how well they understand the concept. Hence, to be able to assess the cognitive structures and reasoning processes, the teacher has to design tasks, which allows learners to demonstrate information about thinking patterns and reasoning strategies. Models of classroom assessment that utilize this knowledge base are rare and research is still limited on how the models work (James & McCormick, 2009) I have also observed that cognitive theory and its science in explaining assessment appears to have taken a back seat regarding current discourses and debates in foundation phase schooling.

I therefore, argue that there is a need to take into consideration expanding perspectives on how people learn and the processes by which knowledge is acquired in subject area domains when framing formative assessment practices in the classroom. Yet, formal classroom assessment models that bring together theories from cognitive sciences, developmental psychology, and studies in pedagogy are lacking in the educational literature.

2.7.4. Sociocultural theory of learning

Sociocultural theory advances the notion that learning is a collaborative activity and occurs through an interaction between the learner and the social environment. The sociocultural theory is relevant for this study since formative assessment is a collaborative activity that is aimed at supporting learners' learning (Black & Wiliam, 2006; Pryor & Crossouard, 2008; Shepard, 2005).

The concept of scaffolding, developed by Bruner, and the notion of the zone of proximal development (ZPD) developed by Vygotsky are used to explain how learning takes place. Vygotsky (1978:56) "… viewed learning as a social process in which learners collaborate with more "expert others, namely teachers or peers to develop cognitive structures that are still in the course of maturing, and which are unlikely to fully mature without interaction with others". Furthermore, Vygotsky (1978: 62) "differentiated between three levels of development, namely: the level of actual development that the learner has already reached, the level at which the learner is capable of solving problems independently; and the level of potential development the "zone of proximal development", the level that the learner is capable of reaching under the guidance of teachers or in collaboration with peers".

The zone of proximal development (ZPD) is the intersection where learning takes place through a process of "scaffolding" (Clark, 2015; Dann, 2017; Heritage, 2010; Palinscar, (1998). Hence, scaffolding occurs when the "more expert" other (teacher) provides support through a process of interaction. For example, a teacher asking leading or probing questions to elaborate the knowledge the learner already possesses or providing feedback that assists the learner to take steps to move forward through the ZPD.

As the learner's competence grows, the scaffolding is gradually reduced until the learner is able to function independently (Tharp & Gallimore, 1988). Furthermore, Vygotsky (1978) viewed ZPD as a zone in which assessment shapes and informs teaching practices. In contrast to constructivists such as Piaget, who suggested learning experiences must be appropriate to the child's current level of development, Vygotsky (1978:90) asserted that “the most beneficial learning experiences are those that are just beyond a child’s current developmental level - those that are in their zone of “proximal development”

In this study, I considered the argument put forward by Moss (2008) and Oxenford’Brian, Nocon, Iceman and Sands (2010) who highlighted the value of the activity system in understanding teachers’ assessment practices. In particular, I chose Engeström’s (2001) CHAT as an analytical tool to draw attention to the classroom context within which formative assessment practices occur and enacted by Grade 3 teachers. My argument is that while it is evident in the literature that every learning theory is significant in explaining how learners acquire knowledge and how learning takes place, it is important for teachers to adopt an eclectic approach to teaching and learning drawing from various theories of learning. Some teachers may opt for a behaviourist approach when the focus is on the development of some basic skills or habitual behaviour, which does not require too much thought. On the other hand, the cognitivist approach may be adopted when a deep understanding of conceptual structures within subject domains is the desired outcome.

2.8. TEACHERS’ PEDAGOGICALCONTENT KNOWLEDGE (PCK) AND FORMATIVE ASSESSMENT: TOWARDS PROFESSIONAL DEVELOPMENT

Although there is extensive research on teachers’ knowledge in mathematics, the literature shows limited studies specifically on what aspects of mathematics teachers need to know to help learners learn (Askew et al.,2012; Hattie & Timperely, 2007). Hence, this section draws on literature that shed light on teachers’ PCK on formative assessment practices and aspects of teachers’ professional development.

2.8.1. The role of teachers’ Pedagogical Content Knowledge and formative assessment

This section draws on the role of teachers’ PCK as a factor that shapes teachers’ and learners’ formative assessment activity. I draw on the Mathematics Knowledge for Teaching (MKT) Model (Hill et al., 2008) to analyse the knowledge components based on the following reasons:

Firstly MKT differentiates between two branches of knowledge i.e., subject matter knowledge (SMK) and pedagogical content knowledge (PCK). This distinction assists me in drawing linkages between pedagogy and the role of subject matter knowledge in best practices in formative assessment. Results further suggest that teachers' pedagogical knowledge (PK) and content knowledge (CK) impact on teachers' ability to provide learners with useful feedback. Furtak, Ruiz-Primo & Bakeman (2017:27) observed that "Without understanding a concept or without knowing common misconceptions related to a subject, teachers were not able to provide accurate and complete feedback.

Secondly the role and importance of teacher knowledge about learners and content (KSC), teachers' knowledge about teaching and content (KTC) and teachers' knowledge about the curriculum [KC] is explained coherently in so far as understanding how the different types of pedagogical knowledge required by teachers can be harnessed to improve their formative assessment practices. According to Ball et al., (2008:78), "Teachers need to be able to create educational situations in which formative assessment can be practiced and should know the roles of students, peers, and teachers in the various formative assessment practices. Furthermore, eliciting students' thinking to reveal their learning process and common misconceptions is an important guiding strategy that teachers should master". Aschbacher and Alonzo (2004:65) found that "using questions or directions that provide conceptual focus was most effective for eliciting students' thinking and fostering learning". Good effective teaching requires teachers to be able to plan teaching episodes in which learners are able to seek clarity and answer questions through active participation. Every effort must be made by teachers to ensure that learners are able to engage in active discussions. Learners' feedback serves as a valuable channel in which teachers can harvest insight into how children learn and acquire knowledge. The information can then be used to adjust instruction and to provide feedback. Researchers such as Birenbaum, De Luca et al., (2011) and Lee & Lyster (2016) noted that teachers struggle to interpret information about learners' learning on the spot.

Thirdly the KCS domain refers to the combination of knowledge about both students and about mathematics (Ball et al., 2008: 401). This knowledge component is significant in "anticipating learners' difficulties, understanding learners' reasoning, and knowing common errors and misconceptions that learners will have with specific content" (Ball et al., 2008:412). KTC is significant to formative assessment practices as it is manifested when teachers initiate classroom discussion, pause for more clarification, use a learner's remark to make a mathematical point or ask questions, or pose a new task for students learning (Ball, et al., 2008). Teaching activities are dependent on the teacher's deep understanding of the subject of mathematics, as well as their understandings of how their instruction will impact on student's learning.

Research suggests that teachers' pedagogical knowledge (PK) and content knowledge (CK) play a significant role in providing learners with useful feedback. Studies by Furtak et al., (2017) showed that teachers, who lack content knowledge and knowledge of common or anticipated misconceptions, struggled to provide accurate and complete feedback. This finding was supported by the claims advanced by Sadler (2010: 112) that formative assessment requires that teachers to provide ongoing "qualitative judgments" on the "quality of learners' work and provide feedback that will mediate their learning". Bennett (2011) and Dargusch (2014) argue that effective feedback requires teachers to have strong content knowledge and pedagogical expertise.

The literature also showed that there is increased emphasis on pedagogical content knowledge over subject knowledge as evident in studies by scholars such as Bennett (2011); Gallavan & Kottler, (2012) and Grossman & Stodolsky (1995). Studies by Bennet (2011) revealed that pedagogical knowledge is shaped by the subject matter knowledge within which it is practiced. Similar findings were revealed in studies by Heritage (2010) which revealed that teachers were able to identify key principles and analyse learner' understanding but struggled to plan the next instructional steps according to learners' needs. Studies by Herman, Osmundson, Dai, Ringstaff & Timms (2015) on the other hand revealed that teachers struggled with analysing and interpreting learners to work, but excelled in the area of instructional "next steps". Based on their finding, Herman et al (2015: 361) concluded that "if teachers' analysis of learners' work does not result in an accurate diagnosis of learning needs, teacher's use of assessment may add error rather than knowledge to instructional planning and decision making". In another study, Shulman and Shulman (2004) found that teachers experience difficulties to "commute from the status of a learner to that of teacher, from being able to comprehend subject matter themselves to being able to elucidate subject matter in new ways, clothe it in activities and emotions, in metaphors and exercises, and in examples and demonstrations, so that it can be grasped by students" (Shulman, 2004: 233). These aspects of teaching are critical in influencing the teacher's capacity to transform understanding, performance skills, or desired attitudes or values into pedagogical representations and actions. Shulman's (2005) view of teaching being shaped by reasoning and understanding is significant as it is consistent with the description of the cycle of formative assessment as advanced by several scholars such as Sadler (1998), Black and Wiliam, (2006), Heritage & Popham (2008) and Shepherd (2013). Evidence from the three studies indicates a need for a balance between the teacher's pedagogical skill and subject discipline knowledge as advanced by Bennett (2011).

Next, I examine aspects of teachers' professional being, namely agency, reflective practices and beliefs as potential factors that shaped teachers' formative assessment practices.

2.8.2. Teacher agency and formative assessment

The literature is replete underscoring teacher agency as an added dimension in understanding how teachers enact their practice and engage with policy (Lasky, 2005; Leander & Osborne, 2008; McGregor, 2004; Priestley, Biesta & Robinson, 2012). Teacher agency can best be described "as the capacity of an individual to act". The capacity to act refers to the capacity to make decisions aligned to achieve the most desirable outcome. The capacity to make decisions should not be constrained by sociological, political and economic factors. Teacher agency also specifies the importance of collaborative team efforts for the common good of all, i.e. peers, learners, administrators and the like. Priestley et al., (2012:124) claim that "there is ongoing tension within educational policy worldwide between countries that seek to reduce the opportunities for teachers to exert judgment and control over their own work, and those who seek to promote it from the outside (central based curriculum design and development – at government level)". On the one hand, some scholars view the lack of teacher agency as a weakness within the school system while on the other hand, there are scholars who see no need for teacher agency and therefore make calls for replacing teacher agency with evidence-based and data-driven approaches.

I am in agreement with the school of thought that raises the importance and need for teacher agency in schools in order for teachers to reclaim their profession as owners of curriculum mediation and teaching. I, therefore, concur with debates and discourses that elevates teacher agency as a strategy to address the complexities of situated educational practices amongst teachers. I view teacher agency as an indispensable element of good and meaningful educational endeavor especially focusing on teacher agency and its relationship and linkage with formative assessment. While the ideological debate about the shape and form of teacher agency is important, it is equally important to understand the dynamics of teacher agency and the factors that contribute to its promotion and enhancement within the school system.

In schools that follow centralised structured curricula, it raises some concerns about the way in which teachers engage with curriculum policies and their agency. Opfer and Pedder (2011: 78) argue that "… part of the problem seems to lie in the often confused discourses encountered in schools and in teachers' often superficial understandings of such discourses". Day, Kington, Stobart and Sammons (2006: 45) argue that "many of the discourses around classroom practice appear to be a combination of competing and vague ideas such as personalisation, choice, learning, subjects". This confusion may arise from a sense of vulnerability that teachers' experience.

Day et al. (2006) single out the characteristic of "vulnerability" as a major constraint in promoting teacher agency. They further argue that vulnerability is the root cause for teacher's professional identity and agency to be in a state of constant flux. According to Wertsch (1993: 16) "Vulnerability can be construed as feelings of powerlessness, helplessness, and feelings of betrayal or being defenselessness in situations of high anxiety or fear". In the school context, this may translate to teachers feeling apprehensive about new policies, new guidelines, and frameworks around curriculum implementation. In the absence of change management, such teachers may be reluctant to change their practices as the change is sudden and new. This resonates with some teachers' beliefs as reported in studies by Kanjee and Sayed (2013); Vandeyar and Killion (2007); and Webb and Jones (2009) that formative assessment practices are limited by prescribed curricula and its guidelines about pacing and ticking the right boxes for curriculum completion. It is no wonder that teachers feel a sense of limited control or feel they are being forced to act in ways that are inconsistent with their core beliefs and values about formative assessment.

There can be no one size fits all. In a study on formative assessment implementation challenges, Priestley et al. (2012) observed that externally imposed systems aggregate to alter the dynamics of schooling, hence impacting on teaching practice. Priestly et al., (2012) also observed that in schools where there was a clear sense of purpose and purposeful relational structures, it enabled collegial working (a division of labour- CHAT), which in turn strengthened teacher agency. In attesting to the above view, Fullan's (2005) states that the cultures within schools impact on teacher agency more than the structures that exist in these schools. This sentiment highlights the view that change in teaching practices requires re-acculturation as well as restructuring so that teacher agency can thrive uninhibited.

The critical role of teacher agency in mathematics teaching was reported in a study by Van der Nest, Long, Engelbrecht (2018) in their Assessment Enhanced Teaching and Learning (AETL) project. The study stemmed out of a concern that mathematics learning and teaching has become summative assessment driven resulting in narrowing of the curriculum. Hence, the researchers engaged Grade 9 teachers in strategically designed test activities to promote teachers' professional development and teacher agency. Van der Nest et al., (2018) were of the view that meaningful learning could be exploited by designing assessment tasks in mathematics that are worth teaching. Another reason for an interest in teacher agency arose from the observation that the inherent agency, which is "core to the functioning of the professional teacher, has been constrained rather than supported in the successive reforms and attempts by the Education Department to improve the teaching and learning of mathematics" (Van der Nest et al., 2018:76). This study focused on supporting and enabling teachers' professional agency, which is understood "…. as the dynamic competence of human beings to act independently, and to make choices in order to advance toward their goals' (Priestley et al., 2013:77). Two key ideas of the agency were explored, namely, "that agency is not intrinsic to a person, but is rather perceived as occurring interactively with the environment, and the environment in which individuals find themselves may enable or constrain agentive action" (Biesta & Tedder, 2007:37).

Findings of the study revealed that teachers direct engagement with the assessment tasks which highlighted critical mathematics concepts, together with the reflective implementation of the task promoted teacher' professional development and subsequently teacher agency.

It also became evident in the study that teachers' active involvement in the implementation and refinement of these formative assessment tasks not only improved teachers' mathematical knowledge but also enhanced their assessment skills. The professional development contributed to teacher agency as the use of assessment tasks were offered in the spirit of collegial sharing. Another important finding was that the agency does not occur in a vacuum, but in response to motivation and within a certain context. Teachers experienced a strong sense of identity as they engaged and adapted to their own complex school environment with many external forces affecting the day-to-day running. In doing so, they were convinced through their own implementation and practice of the value of the assessment resources, which motivated teachers to excel. The teachers' belief systems and how they positioned themselves in relation to policy, to the learners, to the wider community, demonstrated teachers' motivation to adapt their instructional and assessment practices in the Annual National Assessments (ANAs)

2.8.3. Teacher reflection and formative assessment

Reflective practice has been identified as a potential tool to improve teachers' enactment of formative assessment practices. Reflection is an approach that encourages deep thinking by the teacher about their existing knowledge and capabilities, how it has been supported or challenged by new learning and experience, and the identification of strengths to promote and weaknesses or limitations to address (Schön, 2017). Reflective practices afford teachers the opportunity to critically think about the efficacy of their practices before, during and after enactment of instruction for the purpose of refining the practice to improve learning (Schön, 2017). James and Pedder (2006) claim that implementing formative assessment requires teachers to constantly change their thinking regarding classroom roles and behavioural norms. Beauchamp (2015) notes that, when people are empowered through reflection, they are aware of ethical dilemmas and conflicts and how they might arise; have a deep understanding of their own value systems; have learned from past experiences and are brave enough to take the necessary risks to arrive at positive outcomes. By reflective practice evolving into reflective teaching, teachers acquire skills to arrive at solutions and have the confidence to work with others to support those solutions. Reed, Davis, and Nyabanyaba (2002) investigated the extent to which in-service teachers adopted reflective practice after participating in professional development.

They found that "teachers who were least capable of articulating lesson goals were also least able to reflect-in-action (Schön 1987) during lessons or attend to students' misconceptions or requests for assistance" (Reed et al., 2002: 78). Many of the curriculum policy documents suggest the need for a reflective teacher. For example, this is explicitly stated in the Policy on the Minimum Requirements for Teacher Education Qualifications (MRTEQ 2015: 62) as follows:

> "Newly qualified teachers must be able to reflect critically on their own practice in theoretically informed ways and in conjunction with their professional community of colleagues, so as to constantly improve and adapt to evolving circumstances."

In the above quotation, it is implied that teachers need to be able to reflect on their work and to work with colleagues to improve their practice. In a nutshell, it indicates thedevelopment of lifelong learners who are able to problem solve and, in so doing, adapt to their circumstances and enable learning to take place. One of the overarching aims of the curriculum policy is to address the holistic development of learners who should be able to draw from their existing knowledge and problem solve. To achieve these types of outcomes, teachers need to help learners to reflect on their work while reflecting on their own delivery and assessing learners' abilities, so as to adjust their goals and teaching. It is fair to say, therefore, that reflection is an integral part of the learning process. When we reflect we are able to notice our mistakes and take steps to correct them or seek guidance in correcting them. This increases the potential for success and delivery of quality education.

I therefore argue based on the work of Schön (2017) that all professionals have a shared responsibility to enhance their skills and knowledge through continuous reflective practice which allows for the maintenance of standards. This, in turn, leads to teachers who use their self-awareness to improve their teaching, thereby becoming reflective teachers. Teaching in South African contexts is often demanding and challenging, requiring teachers to grapple with complex situations. Being reflective in one's thinking enables teachers to step back from difficult situations and determine how a particular set of problem-solving strategies can be developed to achieve the best possible outcome. The accountability pressures to cover content may result in teachers teaching content that may not be aligned to the abilities of learners. If teachers engage in reflective practice, they will be guided to make the right choices for their learners and be empowered to support those choices.

2.8.4. Teachers' beliefs

Several studies showed that teachers' beliefs and attitudes were important for the deep implementation of AfL (Harks, Rakoczy, Hattie, Besser & Klieme, 2014; Lee & Ginsburg, 2009). Ashbacher and Alonzo (2004) found that teachers' who felt responsible for the attainment of learners' goals focused on the "principles of AfL, instead of the mechanical application of techniques. In the same study, it was found that teachers, who were showed less responsibility, were less inclined to evaluate learners' work, were less committed to giving feedback and were reluctant to revise teaching plans.

Studies also showed that teachers who held constructivist views of learning applied learner-centred pedagogical strategies. (Birenbaum et al.2011; Carless, 2017; Tan, 2017). Moreover, these scholars noted that AfL practices that represented features of quality instruction into-operated learner-centred AfL practices. Marshall and Drummond (2006) found that teachers who valued learner autonomy and viewed learning as being progressive favoured the implementation of formative assessment than teachers with believed in traditional ways of learning such as lecture-based teaching. Jones and Carter (2013:1083), proposed three dimensions to identify and describe teachers' beliefs on assessment. These dimensions are: "purposes and functions of assessment, specified as the distribution of learners according to achievement levels and external evaluation; teachers' perception of curriculum and their professional self-efficacy feeling; and their beliefs about the teaching and learning process and about learners as learners".

In addition, Torrance (2011) draws attention to teachers' beliefs about accountability and formative assessment. Teacher accountability is driven by adherence to standards, prescriptions, and compliance. Torrance (2011) notes that teaching and learning are results driven and argues that summative assessment will always drive out a formative assessment is set in opposition to one another. Valli and Beuse (2007:34) noted that "school and district-based accountability pressures, such as curriculum coverage and systemic external assessments push teachers towards instructional practices that are less focused on mathematics and more focused on skill-based teaching and coverage of content.

From the discussion above, it is deduced that teachers' beliefs will always be value-laden through forces such as school contexts, prevailing social and political contexts, regulations, rules, community expectations, vulnerabilities, lack of teacher agency and the like.

Next I examined three aspects that contribute to teacher professionalism, namely, school leadership and school culture, professional learning communities and continuous professional development.

2.8.5. Aspects that contribute to teacher professionalism

Trumbull and Gerzon (2013) conducted a meta-analytical study of continuous professional development and its impact on formative assessment practices amongst early Grade teachers. Their study concluded that in order for teachers to keep abreast of current trends in formative assessment practices, teachers must be afforded in-service professional development and training on an ongoing basis. They also found that a needs analysis of teachers training needs must be conducted in order to align professional development initiatives to formative assessment practices. The following categories of professional development support need to be made available to teachers if they are expected to enact responsive assessment practices:

School leadership and school culture

Effective leadership and school culture have been cited as prerequisites for the enactment of formative assessment. Moss, Brookhart, and Long (2013) and Noyce and Hickey (2011) argue that both district and school administrators need to be appraised of current practices, trends and be fully conversant of new and revised formative assessment reforms contained in policies, frameworks and training needs.

Stiggins (2010: 233) notes that both teachers and administrators tend to have a very thin grounding in the kinds of assessment knowledge and skills they need because pre-service programmes offer so little “relevant assessment training” especially in aspects related to formative assessment. Moss et al. (2013: 203) claim that professional development for administrators should focus not just on content but also on how to support teachers to improve their practices so that administrators can “lead a school culture that focuses on learning rather than evaluation”. Heritage (2010) asserts that an effective culture for formative assessment requires a coordinated and collaborative process that promotes professional development for administrators and teachers, and also allows time for the practice of new learning and implementation of new tools. In addition to the need for support from district and school leaders, effective formative assessment is also dependent on a culture of shared responsibility between learners and the teacher.

Professional learning communities

Thompson and Wiliam (2008) observed that in educational landscapes where professional learning communities (PLC) exist, there was a strategic approach to engage in professional development amongst teachers. This is irrespective of the PLC being within a school or within a cluster of neighbouring schools. PLCs normally bring together teachers who have a common goal to improve their practice, share best practices and also in some cases share worst practices. All in all, PLCs are more likely to support teacher change that alters entrenched practice (Heritage & Popham, 2008).

Grade level collaborative teams have shown success in improving classroom learning (Saunders, Goldenberg & Gallimore, 2009). Wylie, Lyon, and Goe (2009) noted that even when there is no single person who is well grounded in formative assessment within a group, the members are likely to bring together varying levels of expertise related to formative assessment and use external resources to build their knowledge. Developing a culture of collaboration in the classroom requires far more than additional technical knowledge related to eliciting evidence of learning and using the evidence to inform instruction.

Teachers need opportunities to share their strategies with other teachers to examine what works and what does not work. Practice opportunities should focus not only on the particular techniques but also on the broader processes of assessment and instructional planning. Recent developments of professional development have shifted the emphasis to professional learning in which learning new technique or strategy is less important than developing the teacher as a person, “their values, beliefs, and assumptions about teaching and their ways of seeing the world” (Cranton & King, 2003: 33) techniques. While pressure is a necessary part of the change process as teachers engage in trial and error (Rust, 2010), one cannot expect teachers to go it alone. Delivering professional development is the easy part. Sustaining the change through support is the most overlooked and ignored aspect (Guskey, 2003).

Professional development of teachers’ formative assessment practices

Finding time to allocate for professional development is one of the biggest challenges to successful professional development (Heritage & Popham, 2008). Firstly, a well-designed professional development initiatives can be thwarted by poor attendance, poor quality training in past experiences, failure of principles to understand the value of attendance of training interventions; poor communication of training interventions to be held, poor timing of the training interventions and lastly the cost of attending professional training interventions.

Guskey (2003) noted that most professional development programmes fall short of providing teachers with the rationale or strategies on how to embed classroom assessment into instructional or curriculum planning. The duration of the professional development programmes is at times too laborious to teachers needs and hence, teachers become reluctant to attend such professional development programmes (Heritage & Popham: 2008).

A second feature for effective professional development is that it needs to be ongoing and intensive (Darling- Hammond, Wei, Andree, Richardson and Orphans (2009) Given the complex nature of formative assessment, it makes sense that for formative assessment to realise its full potential for improving learning, it requires extensive teacher preparation and professional development. For teachers to implement effective formative assessment, they require support over time, since changes may happen slowly or suddenly. The teacher also needs time to reflect on their practice and to adapt and revise their instructional practices by integrating their new learnings (Leahy & Wiliam, 2009). Darling-Hammond,et al. (2009: 43) noted that “teachers typically need at least 50 hours of professional development in order to make the innovation part of their repertoire”. Formative assessment is not about the application of techniques but requires a shift in teachers’ thinking about how instruction and assessment are connected, to view feedback as being central to learning and to accept learners as being partners in the learning process (Wylie & Heritage, 2010).

A third consideration for professional development is that it must be connected to practice. Scholars such as Killion (2012); Curry & Killion (2009) and Garet, Ludwig, Yoon, Wayne, Birman, Milanowski (2011) claim that professional development is more likely to be effective when teachers have opportunities to apply what they are learning through professional development in their own practice and reflect on what they have done. Teachers also need adequate time for such practice and trials. Trumbull and Gerzon (2010) claim that professional development must be respectful of teachers existing practices and must, therefore, be grounded in the belief that many of the elements of formative assessment are not new to teachers. Some of the professional development workshops have proved to be insufficient to produce the kind of competence required to mediate learners’ learning. Ono and Ferreira (2010) found that the “cascade” model of professional development, which involved the transmission of knowledge or information from the top to the lower stratified groups of teachers, had many flaws. The cascade model which was based on “training-the-trainer” to ensure that the message “flows down” from experts and specialists, eventually to the teachers was ineffective as it did not take into consideration the local contexts of teachers. Being a transmission model, teachers were passive receivers of information as opposed to being actively engaged.

The fourth characteristic that professional development initiatives ought to consider the local context of teaching in terms of costs and challenges. Elwood (2006) observed that professional development programmes should not be seen as a one size fits all option for teachers and their respective schools. Marshall and Drummond (2006: 139) in their study, highlighted the implication of such approaches which resulted in teachers adopting the "letters" of the activity or the "procedures… sticking to the particular rules". Such an approach limits the adaptability of teachers within the complex nature of the classroom. Vlachou (2015:102) observed that these approaches "failed to address the contextual as well as the relational nature of the activity".

Fifthly, Buck and Traut- Nare (2009) motivated that in-service professional development should focus on developing the capacities of teachers to adapt the activities to the local context and to better understand teachers by engaging them in dialogues about the way their beliefs, motives, and actions shape their practices. Leahy et al., (2005) claimed that there could be no one-size-fits-all package for professional development of formative assessment as different teachers found different techniques useful. Activities and techniques that worked for some teachers did not work for others. Leahy et al., (2005) remind us that was in spite of sharing specific techniques that teachers could use in their classrooms through regular meetings with these teachers.

Sixthly, professional development is most effective when it is content specific. Studies by Garet et al. (2011) showed that teachers benefit the most from professional development that draws specifically on the subject matter content and how learners learn that content than professional development that focuses on general principles of instruction or on the method of delivery. Effective professional development for formative assessment, therefore, needs to go deep into content. Teachers need to try out, collaborate, reflect on and revise their practices. (Wylie, Thompson, Lyon, & Snodgrass, 2008). Similarly, Jones and Moreland (2004) found that the general pedagogical knowledge gained from the professional development workshop was insufficient to bring about meaningful learning. What was needed for meaningful learning was an understanding of more specific PCK integrated with sound assessment practices for the teaching of the new technology curriculum. In the same study, it was revealed that knowledge of characteristics of the subject, knowledge of conceptual and procedural aspects and specific teaching and assessment practices of the subject enhanced teacher's PCK and improved teachers' formative assessment practices.

From the literature study documented in the preceding sections, it became evident to me that in order to explore formative assessment practices of teachers, one has to consider a systems approach and how the sums of the parts of the systems work in interconnected relationships. The sum of the parts of the system has to be viewed from the perspectives of the teacher (subject), the learner (object); the community (district, school, province and national department of education) and the outcomes (student learning, performance, and achievement). Taking this into account, I realised that the interconnections and relationships intersect at a particular point which supports the Zone of Proximal Development (Vygotsky,1978).

Owing to the observation and understanding explained above, I found that the Cultural Historical Activity Theory best aligns to my belief system about how, why, why not, where and when teachers enact formative assessment. I therefore chose CHAT to underpin the theoretical framework for my study.

2.9. THEORETICAL FRAMEWORK FOR THE STUDY - CULTURAL HISTORICAL ACTIVITY THEORY (CHAT)

Eisenhart (1991) supported by Melendez (2002) opines that a theoretical framework must be construed as a blueprint for the entire research one conducts, commencing from planning, implementation, executing and documenting the research. The theoretical framework serves as the point of departure upon which I build and supports this empirical research (Eisenhart & Howe, 1992). The most significant purpose of the theoretical framework as postulated by Eisenhart (1991) is that it allows the researcher to identify the epistemological, philosophical, methodological and analytical approach to the research being conducted. The theoretical framework selected for this study is the Cultural Historical Activity Theory.

2.9.1. Cultural historical activity theory (CHAT)

From the literature review, it is evident that formative assessment is not simply the observation or the measurement of concepts and skills of learners in order to give feedback for support and scaffolding for learning. Teachers' activity as formative assessors is not an isolated act, but is, according to CHAT, intersected by historical and current, social contexts. It is an activity that is part of a bigger systemic gaze. Although it requires varied ‘at the moment” decisions in response to learner’s ongoing needs, these responses happen against a backdrop of policy, curriculum demands, school management and, most importantly, the teachers’ knowledge of what a formative assessment pedagogy comprises. Formative assessment embraces activities ranging from pedagogical *tool*-use, as described in classical Vygotskian theory (Vygotsky, 1978, 1986; Kozulin, 2017), teachers’ understanding of assessment standards, their formative feedback to learners, individually and collectively, and creating opportunities for engaging classroom conversations (Graven & Venkat, 2014). It is this complexity and its dialectical and interactional nature of formative assessment that motivated me to adopt a systemic “gaze” and utilizing CHAT as a framework with which to reflect on the data after analysis. CHAT discourse includes four powerful terms, which require interrogation in order to contextualize this framework within the context of my study. The term “cultural” signifies the “enculturation” (Beatty & Feldman, 2009: 15) of both teacher and learner engagement in formative assessment.

Enculturation of both teachers and learners refers to my assumption that everything that teachers and learners do in terms of formative assessment is shaped by their cultural values, practices, traditions and knowledge structures harnessed from their experiences. The term “historical” is linked to the word “cultural” like it appears in Lev Vygotsky’s (first generation) AT (Vygotsky, 1978; Kozulin, 1990). This means that teachers’ and learners’ culture is located and grounded in their historical past experiences, encounters, and beliefs in- and out of school. Their culture, therefore, draws upon their historical past journeys. Thus, any analysis of what the teachers or learners “do at any given point” (Beatty and Feldman, 2009: 15) must be seen in the context of their historical past. The historical past in question “evolves over time and therefore the analyses of teachers and learner action must be situated along the historical trajectory” (Murphy & Rodriques-Manzaneras, 2008) or timeline.

In the context of this study, the term *activity* refers to what teachers and learners do jointly and with regard to formative assessment. Once again, it is emphasised that the activity of both teachers and learners is shaped and at times modified by both the cultural and historical experiences of the past. The term “theory” refers to a conceptual framework that

I shall follow in understanding, exploring and analysing how teacher and learner's activities within formative assessment practices are shaped, influenced and developed.

By way of explicating the theory, I provide a brief description of how CHAT has undergone and is still undergoing a transformation. I use CHAT as Beatty and Feldman (2009: 15) have suggested: fitting context of the thesis study and making sure that I use it consistently throughout my study, and by the same token, granting that there is no right or wrong way. Activity theory which originated from the work of Lev Vygotsky (1978) (first generation AT) and further developed by Leont'ev (1974) (second generation AT) and Engeström (1999) (third generation AT). Beatty & Feldman (2009:15) describe it as a 'philosophical framework for studying different types of human praxis'.

First Generation Activity Theory

The first generation activity theory conceptualised by Vygotsky (1978:112), situates human consciousness within a "social, historical and cultural context". Vygotsky (1978:114) posits that "human consciousness develops through a mediated activity" as depicted in Figure 2.1. The process of assessment within the first generation AT as applied to this study, denotes the subject as the teacher, as the subject using mediational tools (feedback, PCK, questioning and so forth) towards an object (improved learning) (Pryor & Crossouard, 2008). First generation AT helped me to understand how tools are used in mediating an assessment activity. Vygotsky (1978: 116) posits that "mediated activity is a process of meaning-making whereby the subject uses tools to interact with the object in order to achieve the desired goal". According to Vygotsky (1978) tools are instrumental in the development of human cognition. I argue that, through formative assessment, the learner's cognitive structures are transformed through the subject's (teacher's) mediation of the tools (feedback, questioning, dialogues, PCK) with the object (learner) to achieve the outcomes (enhanced learning). First generation AT is useful for understanding how tools are used in the mediation of learning.

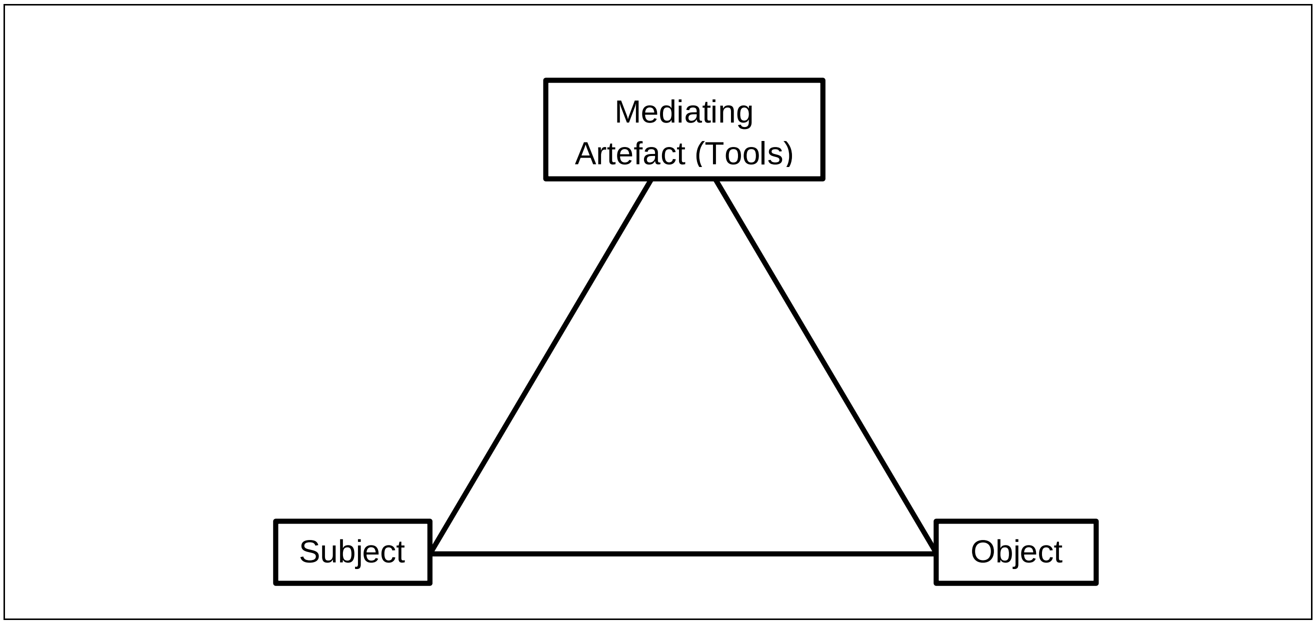


Figure 2.12: Vygotsky's (1978:61) Mediated Action System – (First Generation: CHAT)

Second generation Activity Theory

Expanding on Vygotsky's first generation CHAT, Leont'ev (1981) proposed a three-stage hierarchical structure of human functioning within the system (Figure 2.2). Second generation AT extends the view of learning as one that is dependent on the social and cultural contexts in which the activity is situated, a move from the premise that behavioural, constructivist and cognitivist learning is viewed as a purely internal psychological event (Niewolny & Wilson, 2009). Leont'ev (1981) differentiates between the three levels of activity as follows: The element of *motives* explains *why* something is done. The second level, which is driven by deliberate actions, shows *what* is done and the third level, which consists of operations, explains *how* it is done. Leont'ev (1981) identified the activity as a "unit of analysis, defined as a series of processes within a bounded system" (Yamagata- Lynch, 2010: 20). Second generation CHAT is premised on the view that activity involved a division of labour (a collective group of a shared task) together with individuals completing specific actions.

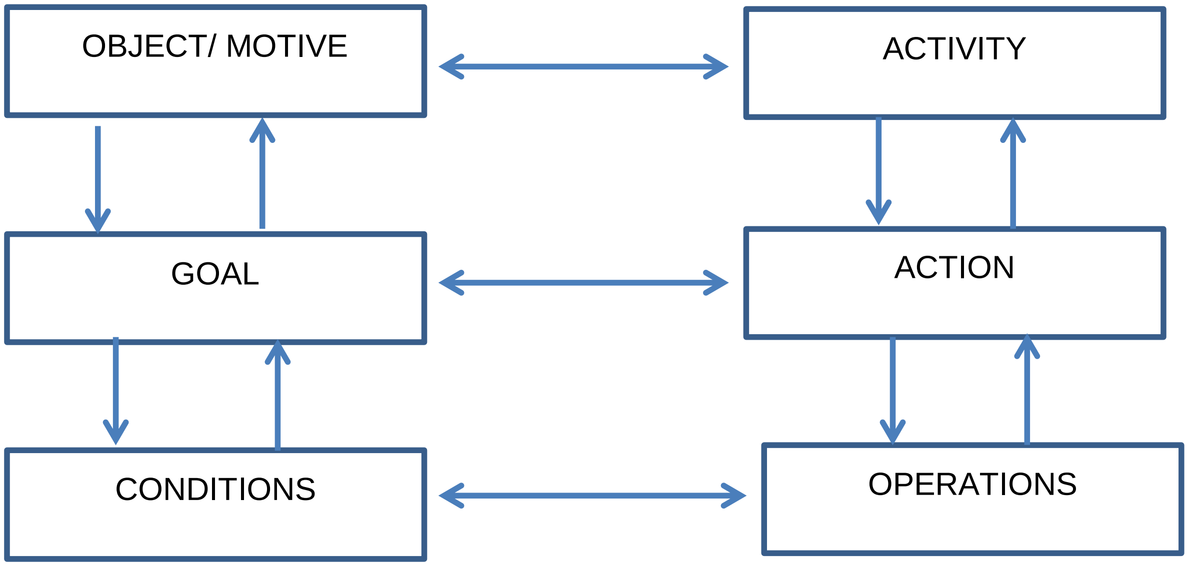


Figure 2.13: Second generation AT (Leontev, 1981: 70*)*

Leontiev (1981) postulated a hierarchical structure of activity. He suggested that motives, emotions, and creativity are inextricably linked as social endeavours (Hardman, 2008: 66). Hardman (2007: 66) concluded that the inextricable link between motives, emotions, and creativity is:

> "…achieved because this model of activity situates individual, goal- directed actions in the social context of an activity. Leontev's (1981) focus on division of labour as a central historical process in the development of higher cognitive functions and the hierarchical structure of activity that it implies, adds to Vygotsky's initial model of human action by illustrating how individual actions are goal oriented while collective activity is object-oriented. Leontev's three-level model of activity distinguishes between individual goal-directed actions and operations and collective object-oriented activity". Hardman (2008: 66)

Even though the motives of the subject and object may differ, the subject and the object of an activity are in a *mutual relationship* in which the subject transforms the object and the constituent of the object transforms the subject. This phenomenon in the activity system is referred to as "internalisation" which occurs when the actions become less conscious and result in operations (Jonassen & Rohrer- Murphy, 1999: 63).

The second level of human functioning is the action of both the subject (teacher) and the object (learner). Within an activity, there may be a series of actions, for example, a formative assessment activity may involve a series of actions such as asking questions to elicit learner's level of understanding, diagnose learner's difficulties, provide feedback, adapt instruction to meet learner's needs, etc. The learner also engages in several actions such as responding to instruction or acting on feedback.

The third level of human functioning is operations, which are unconscious actions, performed by the subjects and are determined by prevailing conditions. In performing actions, the teacher engages in different operations. For example, practical demonstration, illustrations, explanations, discussions, etc. For example, a learner with a learning gap arising from the previous years' work, would experience difficulties in learning a new concept (operation), without the prior knowledge needed for the development of the new concept (conditions). In later writings of Leontiev, Engeström (1987:83) further expanded on Leontiev's "extended concepts by emphasising the role of cultural mediation, the social, cultural and historical context of activity and the relationship between the individual and the collective". Engeström's expanded model comprises of six interacting elements, which are the subject, tools, object, community, rules, and division of labour. The individual's actions are embedded within a system and meaning is derived from a community of people who share the same object (Engeström, 1987:91).

Second generation of AT and the expanded theory (the third generation – see below) has also become known as CHAT (www.iscar.org) and it is premised on the view that learning is dependent on the social and cultural context in which subjects (teachers) are situated, including fixed rules and power relations in the work that is happening in the *activity.* Cole, Engeström and Vasquez (1997) argue that other individuals with whom a subject (teachers) interacts with the object (learners), the social rules that govern those actions and how tasks are distributed among the community (group), influence human cognition. Furthermore, the activity system postulated by Engeström (1991) recognises that there are many voices, traditions, and views that influence the system. Hence, in an activity system of formative assessment in Grade 3 classrooms, these influences can change the expected outcomes for learners. The expanded description of AT is illustrated in Figure 2.14.

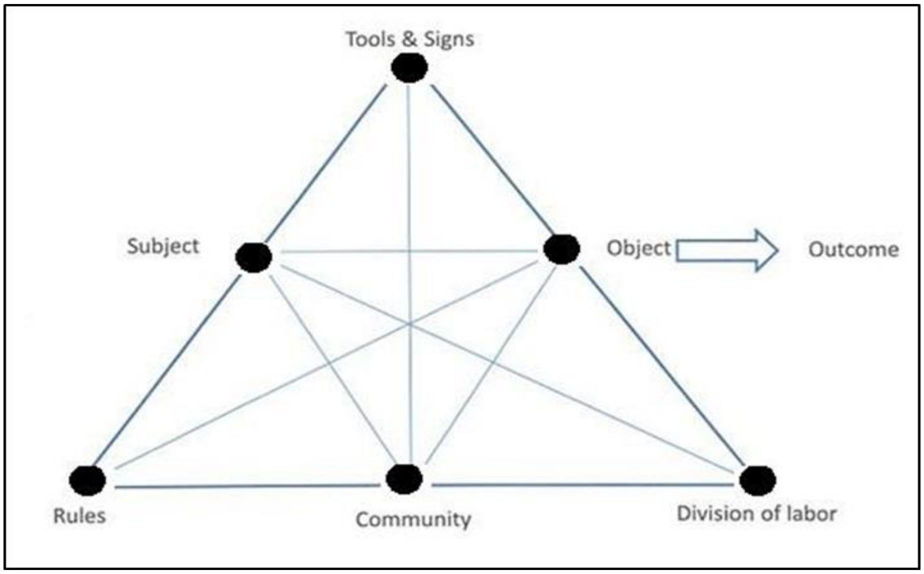


Figure 2.14: The basic structure of an Activity System. (Adapted from Engeström, 1987:21)

While the same tools may be used, the situation in which they are used and the expectations of how learners should work with these tools differ and can, therefore, affect expected outcomes. In the section that ensues, I explore the components of the activity system and contextualise them within the activity of formative assessment.

Activity: In this study, the activity refers to the formative assessment practices in Grade 3 mathematics classrooms.

Outcome: This refers to the desired long-term goal of the activity (assessment. In the context of this study, the desired outcome of formative assessment in mathematics teaching successful learning.

Subject: The subjects refer to individuals who engage in the activity to achieve the outcomes. In this study, the subject refers to Grade 3 teachers who facilitate mathematics learning.

Object: According to Engeström (1999), the object is defined as the "raw material or problem space in which the activity is directed and which is moulded and transformed into outcomes". Within the formative assessment activity, the object refers to Grade 3 learners' building knowledge of mathematics concepts (and facts and procedures).

Tools: These are mediating artifacts not only enable but can also constrain the subject's (Grade 3 teachers) action towards the object (Grade 3 learners). The introduction of artifacts in an activity system influences the norms regulating them. Mediating artifacts refer to the tools, which the subject uses to mediate with the object. Mediating artifacts consist of a range of tools ranging from informal conversations, formal feedback, discussions, dialogue interactions and practical demonstrations (Asghar, 2013). The primary purpose of mediating tools is to provide feedback to learners in order to direct learner is learning. According to Engeström (1999), tools have always played a crucial role in the field of practice. Practical problems and contradictions are related to the use of an artifact to mediate within activity systems.

Division of labour: This refers is the element of an activity system represents the distribution of roles, tasks, and responsibilities among principle objects and subjects (community) within an activity system. The division of labour regulates how objects and subjects are expected to work in unison to achieve the desired outcome of the activity. In the context of this study, it includes collaborative learning, peer teaching, peer assessment, self- assessment, the role and function of school district officials, the learner, the teacher, the role of communities of practice and so forth. The relationships, linkages, interaction, and collaboration between the stakeholders mentioned above constitute the division of labour in the activity system explored in this study. Engeström (2009) highlights issues of power, power relations, contradictions, struggles, challenges and status between, for example, teacher and learner, learner and learner, teacher and teachers, district officials and teachers, etc.

Rules: These are the norms, practices, expectations that control or influence actions, relationships, and interactions within the activity system. In the context of this study, rules refer to pedagogical rules, subject discipline rules, the expectation of the community or policy mandates (such as CAPS). The rules influencing the activity system may include teachers understanding of the learning theories or subject based views of teacher's pedagogies. James (2006) contends that theories of learning has the potential to improve assessment practices and therefore suggests that teachers need to reflect, revise and reconceptualise their belief system and philosophy about how learners learn. Rules may also include compliance with institutions regulatory frameworks, curriculum standards, which may potentially reduce creativity in the design of formative assessment.

Community: This component in the activity system represents the “collective nature of the activity” (Engeström, 2009:39). It includes the objects of an activity other than the principal subjects, who share the same objective and attainment of the outcomes of an activity. In the case of this study, a community, directly and indirectly, includes district departmental officials, the school management team, external training service providers.

Third Generation Activity Theory (CHAT)

Third generation AT proposed by Engeström (Figure 2.4) describes the expansion of one activity system to two or more interacting activity systems (Engeström, 2001). Third generation CHAT is underpinned by five principles (Engeström, 2001).

The first principle is that an activity system is an object-oriented and artefact mediated unit of analysis, occurring within the context of other activity systems. Activity systems are dyadic and somewhat cyclical. In this regard, the point of departure in this study is the emphasis on locating the study in a bounded system of CHAT. The assumptions of a bounded system reveal that multiple interactions are shared in and between multiple activities and that, the boundaries between multiple activities work in harmony to produce an expected or intended outcome. In this study, two different schools are selected one being a ‘priority school’ and the other a non-priority school. The rationale for selecting two different categories of schools was to ascertain and explore how “human activities” (Engeström, 2009: 119) [by Grade 3 teachers] related to assessment for learning is practiced and enacted.

The second principle is that third generation CHAT “embraces the rich diversity and contradictory nature of the human activity as a multi-voiced system” (Engeström, 2009:107), considering relationships and interactions within the community. In this regard, I piloted a focus group interview amongst six Grade 3 teachers (selected through convenience sampling) teaching at schools characterised by different contexts (location, socioeconomic characteristics, school quintile categorisation, teacher experiences, teacher qualifications and so forth.

The rationale for this pilot study was to establish to what extent “multi-voiced” feedback could be elicited.

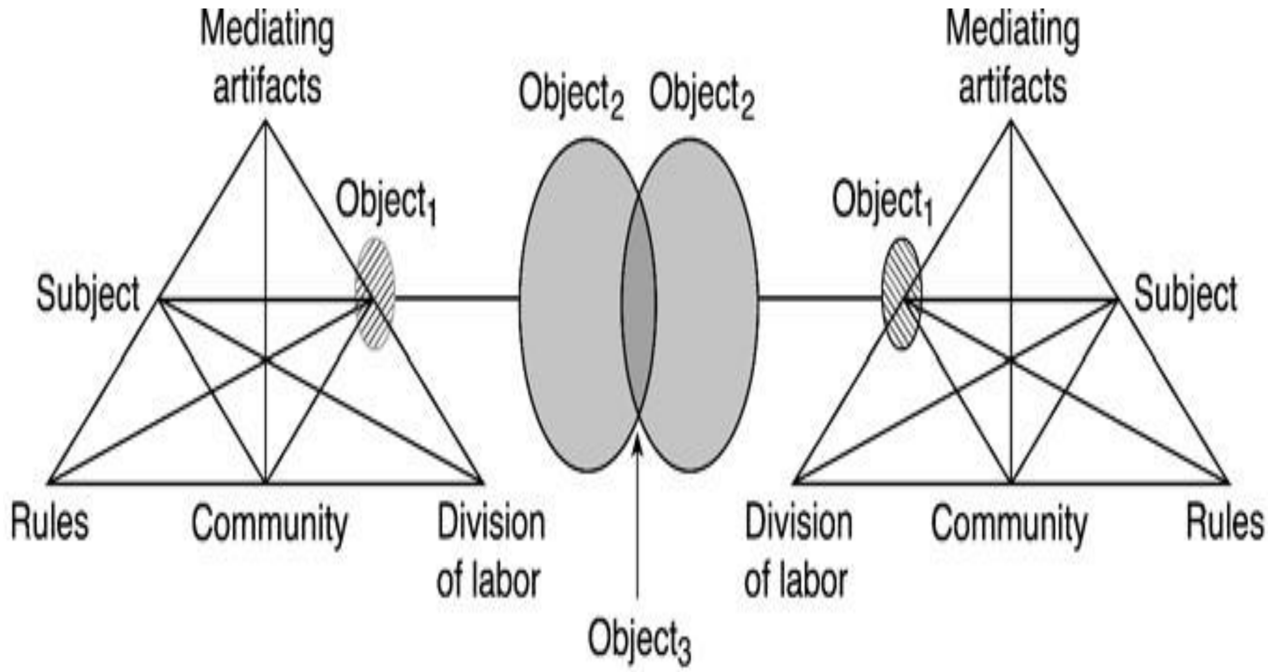
The *third principle* relates to the fact that the activity system has a “temporal nature, change predominates” (Engeström 2009: 215). In the context of this study, I sought to establish and explore how professional development initiatives, policy regulations, knowledge of the curriculum (PCK) affects and influences the CHAT activity system.

The *fourth principle* deals with contradictions that occur within the activity system. The contradiction and tensions are seen as fundamental within an Activity system as they underscore the disparities within and amongst the elements of the activity system. Contradictions are also necessary to establish differences between the elements and the activities as there are development phases inherent in each activity (Kuuti, 1996: 34). Contradictions within the activity system are also referred to as “structural tensions that have accumulated over time (Cole & Engeström, 1993: 9). Engeström (2001: 133) makes a further distinction between the following four levels of contradictions. Primary contradictions occur within the elements of an activity system (e.g. within the community – the school). Secondary contradictions occur between the elements of an activity system (e.g. between the community and the teachers), tertiary contradictions arise when activity participants face situations where they have to use an advanced method to achieve an objective, and fourth level contradictions occur between the central activity system and outside activity systems”. These contradictions may create conflicts which are essential to promote and create change or may also result in development.

The third generation AT (CHAT) offers a useful framework for understanding tensions that exist within an activity system. The knowledge of the source of tension is important as it might influence change and development.

The *fifth principle* of the third generation CHAT is what Engeström (2009) refers to “expansive transformation”. Expansive learning and expansive transformation results in radical changes that occur because of new ways of working, thinking, application and implementation amongst all elements in the activity system. In the context of this study, the relationships and contradictions between the bounded activity systems are explored to ascertain what practices of assessment needs a transformation in order to improve classroom instruction and thereby improve learning. The tensions and contradictions that exist within and between activity systems serve as sources of change and development in the activity systems (Engeström, 1991) and this is the focus of this study, i.e. to investigate how both teachers and learners respond to each other to improve learning through assessment of learning practices and enactment. In exploring the concept of 'expansive learning', I shall also seek to understand the contradictions that may be inherent between the relationships and interactions in the activity system of formative assessment.

CHAT was adopted as a framework to explore teacher's assessment practice and to better understand how the subjects and objects engage and interact in multiple activity systems to improve learning through formative assessment enactment. The analytical lens of CHAT was used to establish how the relationship between the collective activity and the individual's motives cohere, as well as how the activity (formative assessment) transforms the subject. The subject's understanding of the object may change as they interact with different tools (Engeström, 1991) in a bounded system (two schools) as illustrated in the next page.



Subject	Objects	Mediating artefacts / tools	Community	Division of labour	Rules
Grade 3 teachers teaching mathematics	Grade 3 learners	Formative assessment Practices, strategies, enactment, Assessment triangle PCK, feedback	School Classroom District Provincial department of education	Collaborative interaction Teacher-learner interaction District and Provincial education department	Learning theories Curriculum policy (CAPS); CCM Prescribed lessons
Outcome IMPROVED LEARNING OUTCOMES					

Figure: 2.15: Third Generation CHAT (Adapted from Engeström, 2001:136)

Conversely, a subject's (the teachers in this case) understanding of their role in the activity system may change as a function of the interaction with tools and objects. In considering formative assessment as an activity, the proposed outcome is "enhanced learning" through practicing (engaging with) usable strategies for enacting formative assessment. This type of activity (formative assessment) can subsequently be converted into a range of outcomes (such as improved learning) that emanate from reaching the objective/object.

Furthermore, this can include feedback that corrects errors, provides information about new directions for learning, identifies knowledge gaps, affirms conceptual changes, and may develop a learner's metacognition and self-regulation.

2.10. SUMMARY OF CHAPTER 2

This chapter presented the argument that the enactment of formative assessment in mathematics is complex. I have drawn on literature on both formative assessment and mathematics pedagogies to inform the conceptualisation of teachers' classroom practices for the study. I argued that the culture of performativity and the issues of compliance have to a large extent constrained teachers' formative assessment practices. Systems which demand that teachers "perform" and in which individuals are made accountable have potentially profound implications for teachers' classroom practices and their sense of agency. The chapter concludes by arguing that the drive to improve mathematics learning outcomes involves both performativity policy initiatives supported by teacher agency. Unless teacher agency is promoted, teachers will feel a sense of vulnerability and hence act in ways to appease bureaucrats at the expense of effective teaching practices. It can be further deduced that teachers' formative assessment practices will be constrained to the extent of satisfying the requirements of a central prescribed curriculum framework that in many ways do not take into account prevailing contexts at particular schools.

CHAPTER 3

RESEARCH METHODOLOGY: THE DESIGN OF THE FORMATIVE ASSESSMENT INQUIRY

3.1. INTRODUCTION

My experience during this research journey has been beset by many trials and tribulations. As a novice researcher, I have come to understand that conducting scientific research in educational studies is a messy, daunting and challenging task. I was confronted with making research methodological decisions that gravitated back and forth owing to many contradictions and uncertainties that emanated from the literature sources that I studied and reviewed. For example, the research paradigm, research methodologies and research methods that were presented in the literature sources often “competed against each other, contradicted each other” (Mouton, 2004:32) and therefore deciding on an appropriate, design was an arduous task for me.

In this chapter, I provide a rationale for working in an interpretivist research paradigm and for utilising specific methods of data collection and analysis.

3.2. INTERPRETIVE RESEARCH PARADIGM

Morgan (2007: 51) points out that “research paradigms are practices and philosophies” that shapes a researchers’ agenda in conducting research. To clarify the structure of my investigation and methodological choices that I made for my study, I had to consider working in a way that had a close fit and alignment with my topic, problem statement and the research questions to be investigated. In a small scale study, in which there would be no measurement of performance and where the aim was to capture some of the realities in Grade 3 mathematics lessons as they contained (or did not) elements of formative assessment. The study would do this by description and by argumentation that would follow the ‘connecting of the dots’ of a pedagogy of formative assessment. It was important to gain depth rather than width, although the sample had some variance.

According to Yin (2006), the way a researcher conducts an inquiry is shaped by the researcher's philosophy and belief system of the phenomenon that is investigated. Schwandt (1994:90) proposed that “direct thinking and action” depends on assumptions of the researcher in a specific inquiry. The assumptions I made for this study are:

- Grade 3 teachers’ formative assessment practices are constrained.
- Grade 3 teachers in performing (non-priority) schools are more effective than teachers in underperforming (priority) schools.
- Grade 3 teachers are not exposed to effective continuous learning.

I agree with Cohen, Manion and Morrison (2013: 19) who assert that interpretivists view the social world as a phenomenon that can only be seen through the lens of an individuals’ own experience, observation and feelings. Hence, interpretive researchers pay high premium for the opportunity to glean data in its natural setting from individuals who are directly involved with a research problem. Interpretivists therefore begin by trying to understand individuals' interpretation, perspective, and experience of the world surrounding them. This resonates with my research approach to interview and observe Grade 3 teachers in action both in conversations during the interviews and lesson observations in the classroom.

According to Denzin and Lincoln (2008: 9) “an interpretivist understands that research is an interactive process shaped by one’s own personal history, biography, gender, social class, race, and ethnicity, and by those of the people in the setting”. Moreover, “researchers are not detached from the situation under study. They see themselves as participants in the situation they investigate” (Edge & Richards, 1998: 336). Schwandt (1994:11) states that qualitative research is a preferred research approach where the researcher chooses to study a research problem through the lived reality of human beings who are central to the research problem. I wanted to observe and try to understand the teachers’ practice and experiences first hand in their natural setting (in the school and in the classroom. I had no intention to generalise my finding to all Grade 3 teachers, hence I chose the interpretive research paradigm to underpin my study.

I have opted for a design in which I would investigate teachers' classroom practices of formative assessment, with the help of an analytical framework (CHAT). For the rest, I worked on the basis that I should search for the teachers' reality. Through the perspective of CHAT, Crotty's (1998: 79) view that "the" object [learners] cannot be adequately described apart from the subject (teachers), nor can the subject be adequately described apart from the object" had relevance for the design. Pring (2000: 23) supports Crotty (1998) and Grix (2004) by stating, "epistemologically, intepretivists adhere to a subjectivist view in that subjective meanings and subjective interpretations have great importance".

Having considered the arguments advanced by Grix (2004), Pring (2000) and Crotty (1998), it became evident to me that working from an interpretive research philosophy was appropriate for my study. The rationale for following the interpretive research design for my study is aptly summed up below:

- I was able to glean data from teachers based on their reality and experiences of enacting formative assessment practices.
- I was able to glean data purposively from teachers based in differing contexts – both priority schools and non- priority schools.
- Subjective views from teachers were gleaned and documented accurately through interviews and conversations.
- I was able to corroborate and triangulate data from multiple sources – teachers focus group interviews, dyadic interviews with subject advisors, open ended questionnaires that teachers completed, teachers record books of lesson planning, classroom lesson observation, classroom lesson studies, and policy document analyses pertaining to Grade 3 mathematics.

Denzin and Lincoln (2008: 29) argue that "qualitative researchers deploy a wide range of interconnected interpretive methods, always seeking better ways to make more understandable the worlds of experiences they have studied." Interpretivist methodology aims at exploring and understanding phenomenon inductively.

3.3. A QUALITATIVE INQUIRY

In most qualitative research studies, the researcher collects data in an everyday, natural setting (Denzin & Lincoln, 2008; McMillan & Schumacher, 2010; Miles, Huberman & Saldhana, 2014). The goal is "…is to get to know the manner in which the fellow members of a social group validate their particular realities and provide them with meaning, through their participation in social processes" (Denzin, 2003:49). That is, however, not all that is there to it since a researcher who observes activity adds an interpretation, which is subjective. While this may be the case, I made every effort to ensure that all observations made and reported upon was free of bias and subjectivity.

Miles et al. (2014) argue that researchers who follow a qualitative research approach do so because of their belief that human behaviour is never static and that human behavior is always dynamic, dependent on context, time bound and place bound. Also, the findings of most qualitative studies of small samples cannot be generalised beyond a particular study population. Qualitative researchers therefore use a "wide-ranging and profound approach in examining human choices and behaviour as it naturally happens" (Miles et al., 2014: 378).

In summary, a qualitative approach to my study assisted me:

- to consider the situational factors that impacted on Grade 3 teachers' enactment of formative assessment.
- to be contextually aware and sensitive to the conditions, environments and contexts under which Grade 3 teachers teach mathematics.
- to remind myself that the focus of my study was on participants' (teachers) understanding and their classroom practice of formative assessment (McMillan & Schumacher, 2010).
- to consider multiple perspectives on how teachers' knowledge, their skills and their classroom practice affects the effectiveness of formative assessment enactment.

3.4. CASE STUDY RESEARCH DESIGN

I agree with the proposition advanced by authors of qualitative methodology, that a research design is a road map that the researcher follows to achieve set aims, goals, objectives and outcomes for the resolution of a research problem.

The research, or *knowledge problem* that I tried to 'solve' was that I did not know how formative assessment manifested itself in Grade 3 classrooms and hence, I wished to find this out through applied research. In order to conduct an empirical study, I needed a plan and I needed to plan how I would address the research question. I opted for a case study with the parameters that were in alignment with my problem statement, research objectives and research questions.

3.4.1. Classroom case study research design

My research study focused on teachers' practices of formative assessment in mathematics teaching. In order to explore teachers' practices and enactment of formative assessment in action, it was necessary for me to observe teachers in their natural setting (the classroom). I reasoned that a classroom case study research design would allow me to explore a bounded system (a cluster of four schools in the Tshwane South District)) through detailed, in-depth data collection involving various sources of data.

The classroom case study research design enabled me to capture the complexity and situatedness of behaviour of teachers and gain rich and 'thick descriptions' (Cohen et al., 2013: 85) of how Grade 3 teachers' enact / do not enact formative assessment. Case studies in general and classroom case study research design in particular have been described as best suited to research that asks "how" and "why" questions (Stake, 2010; Yin, 2009), responses to which would include data on teachers' activity and their explanations of what they do and why they invest in certain practices pertaining to formative assessment.

While there may be other factors that contribute to learner performance, this study focused specifically on teachers' formative assessment practices, which set the *boundaries* of the case (the bounded system) and the unit of analysis, which in CHAT parlance, includes not only the unit of sampling, but the unit of analysis, which, in the instance of my study, was *activity* in which *subjects* (teachers) engage (Kozulin 2017) in the activity of bounded 'system' is thus a system within the activity system itself. This design enabled me to explore each setting in an attempt to obtain a more comprehensive understanding of the research phenomenon (Creswell, 2007) that has motivated me to conduct this inquiry.

3.4.2. Sampling of cases

Samples can be selected in various ways (Patton, 2015). Purposeful sampling was the option for me. Patton (2015) mentions that purposive sampling, as a non-probability sampling method, is not intended to go beyond description and understanding, confirmed by data and analysis. I also found purposive sampling to be advantageous as it allowed me to reduce cost, time and I gleaned information that is more detailed from my conscious decision to include particular profile of teachers from a selected school district. While it may be that sampling can be biased, I argue that, I overcame this limitation by ensuring that the sample I selected was aligned very closely to my research problem through a multi layered sampling selection. I first conducted focus group interviews with 12 teachers and from the feedback and participation in the focus group interviews I narrowed the sample of teachers to four, for classroom observation.

Four Grade 3 teachers and their classroom activity and two district officials comprised the people in the sample for this study. They were chosen because of their length of service and experience as Grade 3 teachers and their administrative experience in the school district. I used specific criteria to guide the selection of the province, the district, the schools and then teachers (LeCompte et al, 1993:69). Admittedly, the sampling was also convenient in terms of logistics, as I live and work in this part of the country.

3.4.3. Rationale for conducting the study in Gauteng province

Having been in the employ of the Gauteng Department of Education (GDE) as a foundation phase subject advisor, in one of the school districts for over nine years, I was familiar with the interventions, programmes, policies and guidelines administered by GDE to improve the quality of teaching and learning in the classroom. Given this background, I was also acutely aware of some of the challenges that the District, school, and teachers encountered in so far as improving the quality of teaching and learning.

Currently in the primary schools, most of the support programmes are aimed at improving learner performance in mathematics and languages. In Gauteng, for purposes of target support, schools are categorised as “high performing, average performing and low performing” schools. “High performing” schools are also referred to as “non- priority” schools with outstanding learner performance over the past three years, while “low performing”, also referred to as “priority” schools are schools that show low learner performance over the past three years. The criteria used to determine “high performing, average performing and low performing” schools is based on the school’s three year average results in the Annual National Assessment data as well as on the analysis of the quarterly common assessment results. The purpose of categorising schools according to their performance is to identify schools in need of support, as these schools become priority for support and interventions. Many of the provincial and district level support includes a focus on assessment, teaching, learning, learner support and support of school management.

Recently, there has been a concerted effort by GDE to support teachers in content development and curriculum delivery (Annual Performance Plan, 2016). The Gauteng Province’s Member of the Executive council (MEC) for Education, in his foreword message of the Annual Performance Plan 2016 (GDE, 2016:3) stated that, “...quality teaching is the most effective lever available to transform primary and secondary education and to deliver improved outcomes for learners”. With an emphasis on high quality teaching, many of these interventions and strategies focus on building on teacher’s existing practices by supporting teachers in the classroom. One such strategy was the Gauteng Provincial Literacy and Mathematics strategy (GPLMS) which provided teachers with resources such as structured lesson plans to support teachers with content delivery.

Another innovation aimed at improving learner performance in mathematics and languages was the common assessment tasks in the form of standardised tests set at District level. The Gauteng Department of Education also adopted the Curriculum Coverage Model (CCM), which was intended to support schools to achieve total coverage of the curriculum content, and school based assessment by the end of the year. Both the Districts as well as the School Management Teams (SMT’s) using a CCM tool for recording and reporting did this through a monitoring system. Although these strategies were intended to support the “priority schools” and therefore became compulsory for these schools to follow, the “non -priority “schools had an option. The Annual teaching plan is developed from the curriculum policy, which provides a framework to help teachers in pacing the content over each week in a term.

Currently, it is mandatory for all schools to report to the district on a termly basis the progress of the curriculum coverage and school based assessment in terms of percentage completed. The percentage reported is cumulative which means that at the end of the first term, 25 % of content should be covered. Schools that fall behind the target are then prioritised by the district for purposes of support. In addition to the CCM, there are also structured systems where the district monitors the school-based assessments on an ongoing basis. While these innovative strategies had noble intentions, which are primarily, aimed at supporting teachers to improve learning outcomes, the common assessments was one such example where teachers felt highly pressurised because of accountability. This resulted in teachers teaching to the test, as they had to report the termly statistical analysis of the common assessments to the district. My observation resonates with literature that the testing environment is a barrier to teachers wanting to implement formative assessment (Gipps & Stobart, 2003; Sheperd, 2013). I was therefore motivated to conduct my study of how formative assessment practices unfolded during mathematics teaching at selected schools in Gauteng due to the varied interventions and strategies adopted by the Gauteng Department of Education.

3.4.4. Rationale for selecting the Tshwane South school district

I decided to conduct the study in one of the larger districts in Gauteng, namely Tshwane South District which has 133 public primary schools. Being one of the larger districts, it offered me a large sampling frame from which to select my classroom cases for this study. Apart from this advantage, Tshwane South District was one of the few districts that participated in an *Assessment for Learning* (AfL) professional development programme (PDP). AfL is a term used synonymously with formative assessment (Harlen, 2007). The AfL PDP was a project that was funded by the National Research Foundation, Zenex Foundation in collaboration with the Tshwane University of Technology to improve the quality of learning and teaching for all learners in the district.

The programme had three interventions, namely, 1) to develop the knowledge and skills of teachers, to address the learning needs of their learners and to help teachers to use assessment data to address the learning gaps, 2) to capacitate school management teams in providing support to teachers in implementing the strategies at their schools, and 3) to empower District officials so that they could provide professional development to schools and also develop systems and structures for purposes of support. Given the challenges of capacity, cost and time regarding the implementation of such a large-scale intervention, preference was given to selected teachers and HoD's from the "priority" schools.

To ensure sustainability and to scale up the AfL PDP, one teacher from each of the other schools (non - priority schools) was chosen to attend the programme and to serve as the school assessment mentor. The assessment mentor teacher was responsible to cascade the programme to the rest of the teaching staff. The categorisation of schools into "priority" and "non-priority" were based on the learner's performance in the Provincial common assessments as well as the Annual National Assessments. The programme took the form of a series of workshops over a period of three years. Conducting the investigation in a district where teachers attended the AfL PDP presented me with greater possibilities for identifying "living examples" of formative assessment that could be investigated (Black & Wiliam 1998:15).

3.4.5. Criteria used for selecting the teachers for focus group interviews

The study started with twelve teachers who were purposively selected through the recommendation of the district subject advisor based on selected criteria I provided.
The following three criteria were used to guide the process of selection of teachers, namely:

- Firstly, the 12 teachers had to be selected from both school categories, i.e. "priority and non-priority" schools. Teachers from priority schools received training directly by the facilitators from the project while teachers from non- priority schools received once off training by district officials. This criterion was important not only for optimal variation, but to allow me to understand the similarities or differences that may exist in the way teachers from the different school categories enact formative assessment during mathematics teaching.

- The second criteria guiding the selection was the educational qualification of the teacher. The teacher selected had to have an educational qualification in foundation phase teaching, which is either a three-year foundation phase diploma or a Bachelor of Education degree with specialisation in foundation phase.
- The third criteria was in reference to the number of years of teaching experience. The teacher who was selected for participation in this study had to have a minimum of five years of teaching experience in the foundation phase.

The criteria listed for selection of the sample was non-negotiable as I had to ensure that the teachers selected would have adequate knowledge about teaching the mathematics curriculum and would have experience with classroom pedagogy. Using the three criteria highlighted above, 12 Grade 3 teachers with equitable representation from both school categories were purposively selected. I conducted two separate focus group interviews with six teachers in each group. In each focus group, there were teachers from both school types (priority and non-priority) for optimal variation. All 12 teachers also completed an open-ended questionnaire. Based on the teachers' responses in the focus group interviews, I selected four teachers out of the 12 teachers for further data collection through classroom observation.

3.4.6. Criteria used in selecting teachers for classroom observation

The following criteria was used in the selection of four teachers for classroom observation:

- Four teachers were selected. Two teachers were from "priority schools" and two teachers were from "non – priority" schools. The selection was based on their responses, feedback and participation in the focus group interviews.
- In addition to the rich responses of the teachers, the location of the schools was another criteria that was considered in order to observe two teachers on the same day during the regular mathematics daily teaching time. This was significant as it allowed me to investigate formative assessment practices among all four teachers using the same topic (place value) within the same week.

3.5. DATA COLLECTION

Data collection is the lifeblood of research (Creswell, 2007). In order to ensure that data is collected ethically and accurately, the researcher must develop a robust data collection plan or strategy. Denzin (2017:56) states that "…it is extremely important to maintain integrity (accuracy and completeness) while collecting data". The data collection plan should serve as a blue print for the types of data to be collected, the method that will be followed to collect the data and the tools that will be used to collect the data. The plan should also include the time lines for the data to be collected as data generally have a "shelf life" before it becomes obsolete.

3.5.1. Data collection plan implemented for my study

In Table 3.1. (see next page), I summarised the different methods I used to collect data for this study. Different data sources, data collection methods and data collection tools enabled me to ensure ample data triangulation in this study. According to Denzin (2003), data triangulation affords the researcher opportunities to corroborate, data from different data collection tools to establish integrity, accuracy, trends, dis/trends, differences and similarities between what the participants have provided through either verbal communication or written responses / feedback. I considered and factored in the advantages for data triangulation as advanced by Denzin (2003) into my data collection strategy.

Table 3.1: Data collection plan

Research questions	**Data Collection Methods**	**Time line**
How do Grade 3 teachers practice formative assessment in their mathematics teaching? • What do Grade 3 teachers know about the purpose of formative assessment in mathematics teaching? • What do Grade 3 teachers know about how children learn mathematics and how their conceptual and procedural understanding develops? • How do Grade 3 teachers use their knowledge of children's thinking to shape their formative assessment practices in mathematics?	**Two focus group interviews** Six Grade 3 teachers were included in each focus group. Consent letters were signed before the focus group interviews from both the teacher, principal and school district	21 February 2017 27 February 2017
• What challenges do Grade 3 teachers experience in formative assessment practices in mathematics teaching?	Focus group interviews with teachers	
• What support is required by Grade 3 teachers to operationalise the concept of formative assessment?	Dyadic interviews with subject advisors	
• How do Grade 3 teachers practice formative assessment in mathematics eaching? • What do Grade 3 teachers know about the purpose of formative assessment in mathematics teaching? • What do the teachers know about how children learn mathematics and how their conceptual and procedural understanding develops? • How do Grade 3 teachers use their knowledge of children's thinking to shape their formative assessment practices in mathematics?	• Classroom observation • Four Grade 3 teachers • Three consecutive lessons X one hour duration • Lessons were video recorded. I consulted and appointed a service provider to video record each of the lessons • I took field notes during each of the lessons • Consent letters were signed before the classroom observation from both the teacher, principal and school district • Stimulated recall interviews	

Denzin (2003) supports the thesis that it is incumbent on researchers to mine data from as many sources as possible in order to establish multi views and perspectives on the research problem to be solved. I also found that by mining data from a wide variety of sources, I was able to establish confirmation about particular trends, methods, strategies regarding formative assessment. I also noted that extracting data from multiple sources assisted me to validate, verify and complement similar data and findings of empirical research related to formative assessment.

3.5.2. Primary data collection

Primary data was gleaned through the following techniques:

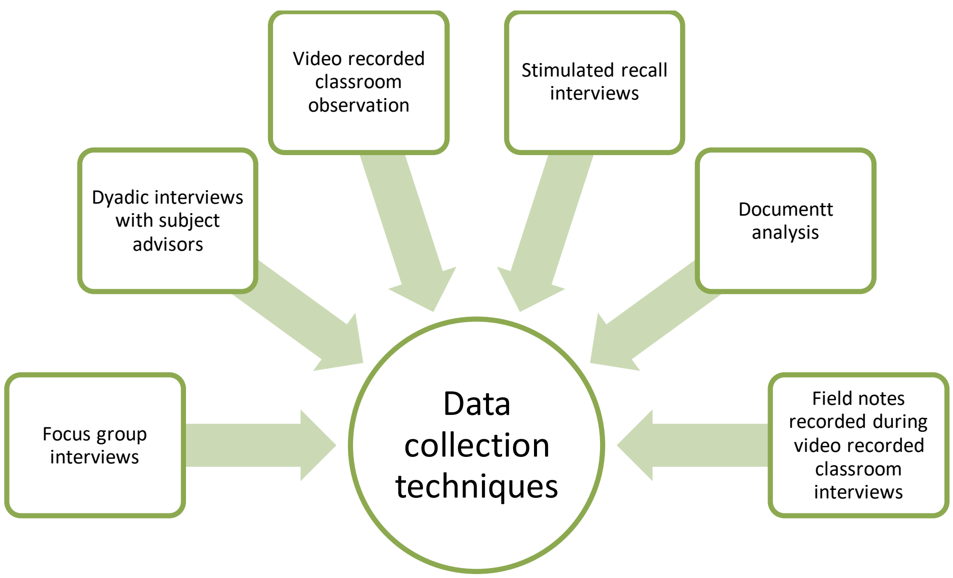


Figure: 3.1: Data collection techniques

3.5.3. Focus group interviews

I used focus group interviews to collect data because this data collection strategy helped me to collect high-quality data in a social context (Patton, 2002). Bringing together six Grade 3 teachers in one venue enabled me to understand how formative assessment is enacted in mathematics teaching through the lens of teachers themselves. I was able to understand and explore the experiences and challenges of enacting formative assessment from the viewpoint of the participants (Grade 3 teachers) (Khan & Manderson,1992)

I considered the motivation proposed by Khan and Manderson (1992:78) who argued that it is crucial to ask one's self "why and when focus group interview" should be considered in research. Firstly, focus group interview proved to be a "valuable research instrument when the researcher lacks substantial information about the subjects" (Stewart & Shamdasani, 2014:140). Secondly, focus group interviews provided me with "a rich and detailed set of data about perceptions, thoughts, feelings and impressions of people in their own words" (Stewart & Shamdasani, 2014:140). Thirdly, focus group interviews proved beneficial because I intended to find out firsthand how the subject has understood the enactment of formative assessment in mathematics teaching.

Two focus group interviews were conducted. Six teachers attended each focus group interview. The teachers attending the focus group interview were selected purposively following a non-probability sampling method. Both focus group interviews were video recorded and thereafter transcribed. In conducting the focus group interviews, I went through the following phases:

Table 3.2: Phases in conducting focus group interviews

Phases	**Action / activity**
Phase one: Planning the focus group interview	This phase comprised the pre planning stage of the focus group interviews. In this phase the following activities were completed: • Request for permission to conduct research – from the School district • Recruiting 12 Grade 3 teachers. Liaised with three senior education specialists from the selected school districts • Signed consent letter from 12 teachers and six schools • Identified the location of the six schools • Arranged transport for teachers to attend the focus group interviews • Sought advice from my supervisor about semi structured questions to pose – in alignment to my research questions • I planned for a flexible duration of the focus group interviews – but I had in mind that the FG interviews should not exceed a two hour duration • I developed an interview guide which was a set of semi structured questions that will be used to "steer the focus group interview" (Yin, 2010:110)
Phase two:	• I followed a semi structured approach

Conducting the focus group interview	• Although I had an interview guide, I adapted the list of questions posed to invoke a just in time response from the participant so that relevant and appropriate feedback was received to enable me to answer my research questions • I followed my interview protocol by: o Welcoming all the participants o I then introduced myself o I went on to explained the purpose of my study and why these select individuals were chosen to participate in my study. o I explained the purpose of audio and video recording of the data. o I provided clarity on how the focus group was structured and the approximate duration of the interview o I outlined and sought consensus on the ground rules as well as the discussion protocols. I reinforced the importance of allowing everyone the opportunity to speak and to listen to one another. It was also brought to the participants' attention that the moderator might interrupt where deemed necessary in order to bring back into focus the discussion at hand. o I also brought to the attention of the participants that the data harvested will be kept in strict confidence and that their identity will not be divulged in the analyses of the data and the dissertation in general.
Phase three: Data analyses of the focus group interviews	The focus group interview recordings were transcribed. Each transcript was allocated a code for ease of reference. I then followed the constant comparative method whereby: • I read the first interview transcript – approximately three times in order to familiarise myself with the participant's feedback • I then coded the transcripts using MS Word Review function. • Similar codes were then grouped together • Each group was then thematised for analyses and discussion

Paired (dyadic) interviews

In examining the main research question in this case study, which is "How do Grade 3 teachers practice formative assessment during mathematics teaching" I conducted two *paired (dyadic)* face-to-face, in-depth interviews with four teacher participants and one paired interview with two subject advisors.

Paired Interviews

To gather information about Grade 3 teachers' knowledge and experiences of formative assessment in mathematics, I considered paired interviews most appropriate in order to allow teachers to engage in a dialogue. The four teachers who were purposefully selected for the classroom observations were chosen for the dyadic interviews. Kim, Lavonen and Ogawa (2009) view this format as a cross between focus group interviews and individual interviews.

The advantage of paired interview is that it allowed for data to be collected from two participants at the same time and provided the researcher with in-depth 'guided conversation' data as the respondents drew from each other's experiences and ideas, which they used to recall and think differently about their own practice (Morris, 2001:556). In order to extract and glean rich data from the paired interviews, I had to listen attentively and make meaning of what is being said by the participants in guided dialogue (Rubin & Rubin, 2012:17). Additionally, because respondents have a working relationship, they were comfortable to interact and to reveal their understanding of formative assessment and could easily fill in gaps in each other's responses (Houssart & Evens, 2011:65; Morris, 2001:560).

They also asked questions for clarity, especially for concepts which they did not understand (Yin, 2011:134). This also gave me time to observe non-verbal communication and facial expressions of the respondents, which showed how confident, hesitant, or unsure (Babbie, 2014: 326; Wilson, Onwuegbuzie & Manning, 2016:1555) they are about certain questions.

Because the question in the interview protocol was semi-structured, it gave me the opportunity to pose additional questions and the opportunity to investigate further specific issues and other notions that emerged, based on the respondents' response (Flick, 2009; Fossey, Harvey, McDermott, & Davidson 2002; Merriam, 2009; Yin, 2011). Thus, probing for clarity expanded respondents' responses as they cited detailed examples from their own practice. This showed application of their understanding which is regarded as rich data (Babbie & Mouton, 2014: 386).

To avoid dominance from participants, I directed the conversation and maintained control over the interview (Flick, 2009). Firstly, I did this by informing the respondents of the approximated interview time, posing the questions directly linked to the research question and giving the respondents appropriate verbal and non-verbal feedback such as nodding, taking notes and body language signs to show respondents to continue as suggested (Patton, 2002). Questions were rephrased (Arksey & Knight, 1999:395) to give equal opportunities for the participants to express themselves (Babbie & Mouton, 2014; Creswell, 2014; Houssart & Evens, 2011; Morris, 2001).

The interviews were conducted at a school venue that was convenient for each teacher. I sought written permission for access to the venue through the school principal. The school venue was regarded as suitable because respondents could relate to it as their own, secure environment. At the beginning of the interview I introduced myself once again and explained the purpose of the study. Some ground rules were also highlighted to the interviewees The approximate duration of the interview was explained and consent forms to record the interview was then signed (Trochim, 2006).

As a researcher, I also listened attentively to look out for incomplete responses and thoughts. In many instances, the respondents were asked to give examples, to elaborate and clarify their responses, which was done for all respondents who required it. At closure, respondents were thanked and informed about the rest of the protocol for data accuracy (Babbie & Mouton, 2014). All interview sessions were audio recorded to preserve participants' data and assist the researcher afterwards during the analysis (Hair, Ortinau & Bush, 2008). The researcher immediately transcribed the recordings by herself (Babbie & Mouton, 2014).

Video recorded classroom observations

To get an actual sense of the 'scene' of Grade 3 teachers' formative assessment practices during mathematics teaching, classroom observations were conducted in the Grade 3 classrooms, using a pre-designed observation schedule as a 'silent' observer (Babbie, 2015:331; Merriam, 2009). The schedule is attached (Addendum D).

My presence in the classroom afforded me the opportunity to collect data in an authentic and natural setting because I could see 'with my own eyes' the primary data of teachers' formative assessment practices (Yin, 2011:143). In the classrooms, I took field notes and recorded the events on video (Babbie & Mouton, 2014:335). This gave me an opportunity to get an "inside view of the respondents' authentic interaction" and behaviour in the classroom (Babbie & Mouton, 2014:412). A total of at least three sequential lessons was observed for each teacher in order to capture the teaching of "place value" (Topic) from beginning to end and to obtain a complete picture of their formative assessment practices. Using (Black & Wiliam 2009) model of formative assessment, it allowed me to identify formative assessment episodes as not all activities may be formative, but information sharing and instructional. The notion of a formative assessment episode refers to the activities that provide information which can be used as feedback by teachers (William et al. 2004). In locating the formative assessment episodes within the teaching activities during a mathematics lesson, I was able to observe the teachers' pedagogical content knowledge in each formative assessment episodes, using components of the MKT model. The observations helped me to examine how teachers translate their PCK during their formative assessment practices as they adapt their lessons to meet learners' needs. All the lessons were video recorded and field notes were taken during each classroom observation episode. I categorised the field notes according to the different components of MKT with an additional column to list formative assessment episodes occurring during each teaching activity.

Stimulated recall interviews

Stimulated recall interviews with teachers were conducted to probe teachers' thinking and understanding in terms of the relationships between their knowledge domains. At this stage, teachers elaborated and clarified practices observed when teaching while watching episodes of themselves teaching. Reflection is necessary for teachers' empowerment in general and for making sense of their teaching practices in particular (Babbie & Mouton, 2014). Through these interviews, teachers' perceptions of formative assessment was elucidated.

Document analysis

Additional data was obtained through analysis of documents, including teachers' lesson plans, assessment recording, minutes of departmental meetings and learners' workbooks. Analysis of lesson plans confirmed data collected from teacher's interviews and classroom observation and provided evidence about the nature of teacher's written feedback and error analysis pertaining to formative assessment. These documents were used to assist in the description of the episodes and to support the transcriptions and analysis with information or clarification.

Multiple data sources enabled triangulation, offering varied sources of data to provide a comprehensive picture of formative assessment practices - more varied than a single data source. According to Pandey and Patnaik (2014), the collection of data through multiple data collection tools ad principles adheres to the principles of activity theory and case study methods. The collection of data through multiple tools (stimulated interviews, classroom observation, document analyses, and focus group interviews) allowed me to triangulate data in order to explore a wholesome and integrated perspective and understanding of how Grade 3 teachers enact formative assessment.

3.6. DATA ANALYSIS

Data analysis, according to Merriam (1998:178) is the "process of making sense of the data". Based on the qualitative nature of the research, this study followed an inductive analysis where I "synthesised and made meaning from the data, starting with the specific data and ending with categories and patterns" (McMillan & Schumacher, 2010: 394). For the purpose of this study, I selected the constant comparative method (Merriam,1998:156) from the "range of qualitative data analysis strategies that exist, namely; ethnographic analysis, narrative analysis, phenomenological analysis, and constant comparative analysis". The basic strategy of this approach is to "constantly compare bits of data with each other" (Merriam, 1998: 179) to determine if they have something in common. Segments of the data are first coded. These codes are then compared which leads to provisional categories that are again compared to each other, resulting in the search for recurring patterns in the data.

Figure 3.2 below depicts the data analysis plan that I followed in analysing the data for this study.

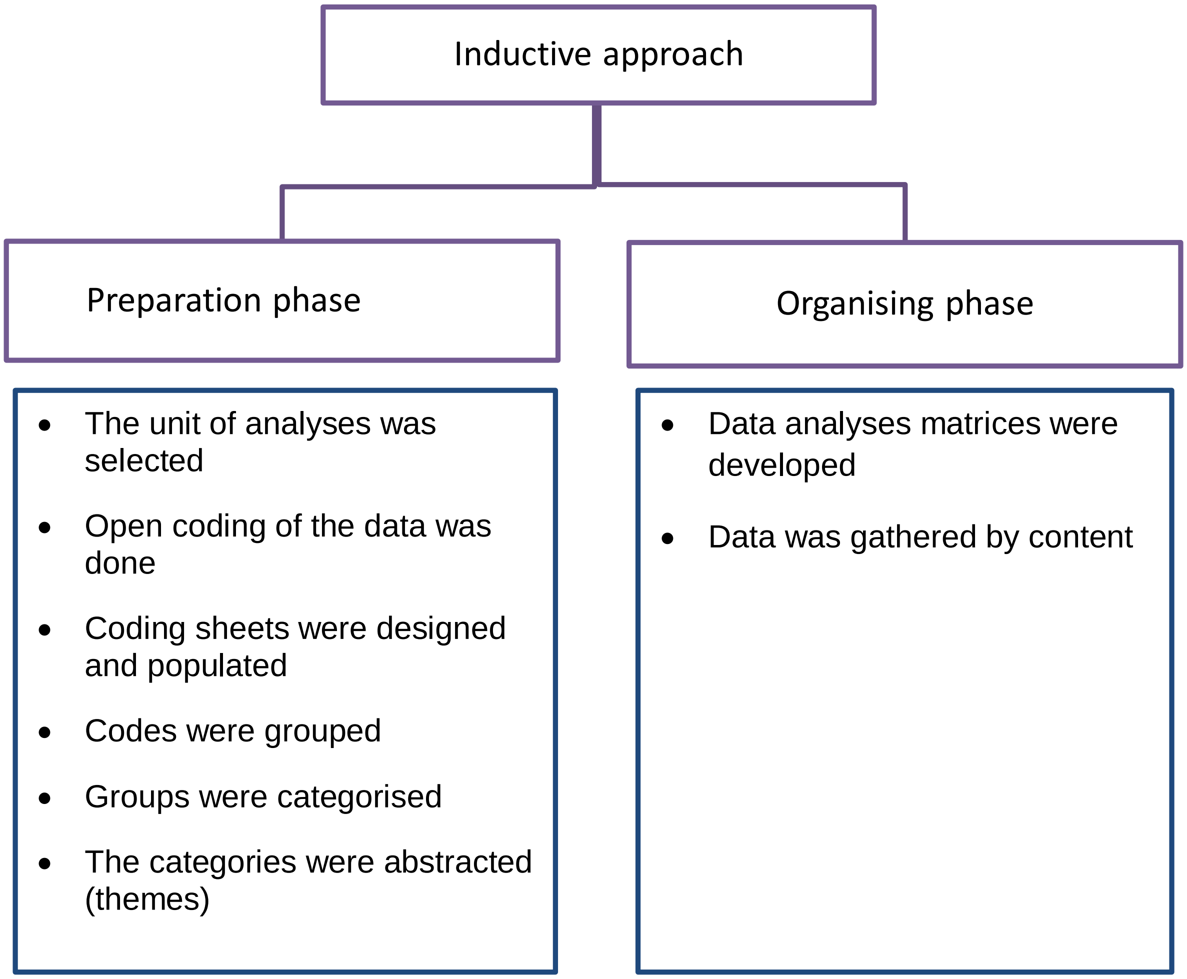


Figure 3.2: Preparation, organising and resulting phases in the content analysis process: Adapted from: Elo and Kynga¨s (2007: 110)

According to McMillan and Schumacher (2010: 395), "data analysis is an ongoing part of the study". It is done *during* the data collection as well as *after* all the data have been collected. As I considered the point advanced by McMillan and Schumacher (2010), I started the process of transcribing the data immediately after collecting each set of data, and went on to unitise the data. I found this process to be enriching since it afforded me the opportunity of familiarizing myself with the data. I continued with this process until all five dyadic interviews, and eighteen classroom observations were conducted.

Once each interview and lesson observations were transcribed, each page of the transcript at the top right hand corner with a specific code. The transcript code for each of the pages were as follows: the pseudonym (name of the interviewee) followed by the page number of the particular data set (Mykut & Morehouse, 1994: 128). For example, Mina / 3 refers to the transcription of the interview with Mina, while 3 refers to the page number of the transcript.

I used the thematic content analysis (Creswell, 2007:156; Creswell, 2010:16) and where deemed feasible discourse analysis as described by Henning *et al.* (2004). The 'raw' data was organised and prepared per data source (Henning et al., 2004) by identifying segments of data that were responsive to the research question and sub-questions (Merriam, 2009:176), from the classroom observation, focus group interview transcriptions, paired interview transcriptions, classroom observation video recordings, classroom observation field notes and documents gathered. Identified data was then segmented into meaningful units and coded in grounded theory mode (Strauss & Corbin,1998; Henning et al., 2004). These codes were then clustered into categories. Those with similar categories were compared, interpreted and grouped into themes (abstraction). Thereafter, I discussed and presented the findings of the study through themes and sub- themes, followed by interpretation of the overall pattern and meaning of the data against the theoretical framework of the study as well as the literature review. This allowed me to be able to formulate a substantive theory of formative assessment for the two classrooms observed, which could in turn be interpreted for generalisation by disseminates.

3.7. RELIABILITY, VALIDITY, AND TRUSTWORTHINESS

Validity, and reliability are important constructs to consider in order to ensure quality and authenticity of research findings (Kvale & Brinkman, 2009). These research terms appear in all handbooks of research methodology for beginners. Kvale and Brinkman (2009), Maxwell (2006) and Silverman (2015) are among those authors who promoted the operationalisation of validity and reliability within qualitative research since the 'qualitative turn' in the social sciences. They argue that validity and reliability measures "offer the most effective means of evaluating the quality of research, and those researchers have a general understanding of these terms even though they are used them differently in qualitative and quantitative research" (Kvale & Brinkman, 2009:54). Reliability and validity in qualitative research have been described as *subsets* of 'trustworthiness', by a host of authors (Merriam, 1998; Morse, Barret, Mayan, Olsen and Spiers, 2002; Golafshani, 2003; and Noble & Smith 2015). The discussion that follows is based on the key aspects of rigour being reliability, internal and external validity as well as trustworthiness that was maintained in this study.

3.7.1. Reliability

Noble and Smith (2015) describes reliability as consistency of analytical procedures used in the study. In qualitative research, however, the idea of replicability and reliability is rarely used because of the subjective nature of qualitative research. According to Eisner (2017), a sound qualitative study would simplify a rather complicated or confusing issue and do so clearly and methodically. Hence, when we talk about reliability we are referring to the quality of the research process and whether the process could be replicated. For this there will have to be evidential warrant; thus, the process has to be declared in some detail. If the process is not clear, the validity of the findings may be in doubt. Stenback (2001) argues that quality of research is based on understanding (*verstehen*). If the problem under study can be clearly understood, the work can be considered as reliable, but with the proviso that a clear *audit trail*, or *chain of evidence* is documented (Henning et al. 2004).

3.7.2. Validity

According to Guarino, Hamilton, Lockwood and Rathbun (2006), qualitative research can be said to be valid if the findings are believable by scholars in the field and by the participants in the study. The validity of the construct means that it has to be honoured, in other words, that the study was indeed investigating the construct of the unit of analysis (Trochim, 2006). Said differently, the findings of the research are supported by evidence and the findings are honoured by clear mechanisms/measures to support reliability. Another important aspect of validity is *relevance* and contextual validity (Hammersley, 2018). This means that any research study must be meaningful and useful to the intended audience.

The concept of validity is described by a wide range of terms in qualitative studies. Golafshani, (2003) highlighted the fact that some researchers have questioned the place of the notion of validity in qualitative studies. However, Golafshani, (2003) asserts that there has to be some kind of “checks” or “measures” or standards that can be used to validate findings. Due to the conflicting views of the concept of validity for qualitative studies, Creswell and Miller (2000) suggested that researchers could develop their own standards based on their perception of validity and assumptions implied in their study. To specify research standards a difference between internal and external validity is made. Guba and Lincoln’s (Guba & Lincoln, 1989) suggestions for an alternative lexicon has been taken up by various researchers.

Noble and Smith (2015) refers to internal validity as with validity referring to “the integrity and application of the methods undertaken and the precision in which the findings accurately reflect the data”. To assess the internal validity of a study, Merriam (1998) recommends researchers to ponder if their study is addressing the correct parameters. She suggests triangulation, member checks, peer/colleague examination, statement of researchers’ assumptions, and engagement in the research situation as strategies to ensure validity of research findings. Morse et al. (2002), Davies (1999) and Mishler (2000) all caution that these strategies would vary from research project to research project, depending on what standards the researcher chooses to follow.

External validity also referred to as generalisability in qualitative studies, is the ability of the researcher to apply research findings to a broader group or context (Noble & Smith, 2015). This parameter addresses the applicability of research findings. According to Merriam (1995), this is the cornerstone of qualitative research because it looks at the possibility of extrapolating the results to the wider population, not necessarily generalising the findings beyond the sample population. However, Stenbacka (2001) disagrees with Merriam (1998). The author argues that because reliability is based on measurements it is irrelevant in qualitative studies. Despite this criticism, Meriam and Tisdell (1995) points out that qualitative studies aim to understand a phenomenon rather than finding out what is generally true of them. I have tried to resolve this issue for myself by invoking concepts of how my study can arguably ensure overall trustworthiness.

3.7.3. Trustworthiness

As already noted above there has been much debate as to standards that need to be applied to determine the trustworthiness of qualitative research findings. Several qualitative research scholars, such as Mouton (2004) Creswell (2003) and Noble and Smith (2015) have prescribed four primary strategies to maintain trustworthiness in qualitative research, namely: credibility, transferability, dependability and confirmability as baseline constructs to ensure trustworthiness in qualitative enquiry. These are lexically different to the terms of conventional scientific research, but upon closer analysis it is evident, to me, that these are terms to make qualitative researchers more 'restful' about their work, when compared to quantitive studies with conventional usage of the terms of validity and reliability especially. Creswell and Miller (2000) suggested that researchers could emphasise a suitable combination of standards based on their perception of appropriate trustworthiness assumptions related to their research design. Consequently, for this study, four prescribed standards mentioned above and two additional standards being triangulation and expert evaluation were used to show how trustworthiness of the research findings were maintained.

3.7.4. Credibility

Ary, Jacobs and Sorenson (2010) describe credibility in qualitative research as a process to establish confidence and or trustworthiness in the data and data analysis used in the study. It has some commonalities with the notion of reliability. However, realities are based on individual interpretations of a phenomenon in a particular social context. Smith and Ragan (1999) concur with this argument and state that interpretation of the results rests on the judgement of the reader based on their understanding of the phenomena as explained in the findings of the study. To enhance credibility this thesis study included member checking into the findings. All transcripts were forwarded to the participants respectively to confirm whether or not the discussions recorded were authentic and a true reflection of what they said in the interviews. Participants were allowed to remove phrases if they felt any mental or physical harm may befall them. Finally, the researcher involved all participants by requesting feedback on the data, interpretations and the findings of the study. Lincoln, Lynham and Guba (2011) mention that one of the most reliable techniques to ensure credibility in qualitative studies is through member checking.

3.7.5. Transferability

Maxwell (2012) defines transferability as the possibility of using or applying research findings to a broader population besides the one under study. In other words, transferability in this study pertained to the extent to which other provinces could possibly use the findings and apply them in discussions in their contexts. Patton (2015) notes that transferability has posed a challenge to many qualitative researchers because of the findings. Seale (1999) therefore recommends that researchers should provide a detailed and clear description of the methods, research design and assumptions employed in the study.

In this study, I provided a clear description of the data collection process such that users or other researchers may be able to relate to the recommendations that the researcher attaches to the findings and hence make valued judgements on whether the research outcomes can be transferable. In the first chapter of the study, an extensive background to the study was also provided to enable users to understand the context underlying the study. As pointed out by Noble and Smith (2015), the assessment of transferability of the research findings rests on the user.

3.7.6. Dependability

Dependability has been defined by Merriam (1998) as the possibility of replicating study outcomes under similar conditions and participants. This helps to ensure or show consistency in the research. However, because the study is dealing with human beings whose behaviour varies over time, the process of dependability is difficult to achieve. The researcher also acknowledges that, the study involves political players; hence, their position and role in government might influence their perception of the problem under study. It is therefore possible that if a similar study is conducted with different respondents, the outcomes will vary.

To resolve this issue Merriam (1998) suggests three techniques to ensure dependability of research findings:

- The researcher must explain in detail all the assumptions underlying the study.
- Use triangulation in the study.
- Make audit trail of data collection and analysis possible.

This study incorporates all of these techniques. Firstly, the study details the context underlying the study in the first chapter. Secondly, the process of triangulation is followed and is explained in ensuing section on triangulation. Finally, it is possible for an audit trail to be carried out. The researcher carefully documented all data used in the study and the methods followed have been clearly and elaborately explained and justified with all the evidences appropriately numbered and highlighted in the section titled Appendices in this thesis.

3.7.7. Confirmability of the findings

Confirmability is described as the extent to which the outcomes of a study can be corroborated to other similar studies. Auditing has been suggested by Seale (1999) as a prominent technique to ensure confirmability of research outcomes. To facilitate this process I "...laid out a transparent and clear description of the research process from initial outline and through to the development of the methods and reporting of findings" (Kvale & Brinkman, 2009:87). In addition, Imaintained a research diary wherein challenges and issues encountered were documented. This in turn assisted me in maintaining linkages between the study's aim, design and research methodology. All the transcripts both the hard and soft copies (recordings) from the interviews with participants were archived appropriately and hence can be made available to respond to any challenges on the findings.

3.7.8. Triangulation

Blaikie (2007) defines triangulation as the use of different methods and measures to cross examine an empirical phenomenon and thus deal with issues of bias and validity. Brannen (2005) also refers to triangulation as the use of outputs from various sources to ensure consistency. Triangulation can be utilised by researchers to compare data collected through respondent verifications, as was the case within this study to gain different perspectives and enhance understanding of the phenomena under study. Creswell (2003) maintains that triangulation is an important technique to improve trustworthiness of qualitative research outcomes.

In this study, I followed data triangulation (collected data through multiple sources, namely focus group interviews, document analyses, classroom observation and stimulated interviews). Other methods of triangulation followed in this study were that of member checking; the interviewing of a number of participants in similar portfolios as well as clarification of biases before any interview was conducted. The views of the interviewees were triangulated to inform the research findings and further to this were reported from the analytical perspectives of three independent researchers' analysis using a "word cloud" analysis (Wijnhoven, 2012).

3.7.9. Expert evaluation

Three independent experts with extensive knowledge in communication were used to evaluate the study. They were briefed comprehensively on all the evaluation tools used and on the research assumptions to eliminate any biases. During the working sessions emerging themes were discussed, assumptions explained and collaborative consensus reached.

Despite the strict processes that the researcher followed throughout the study to ensure trustworthiness of the research findings, it should however be noted that, only the user of the information can provide valid judgements based on the suitability of the research outcomes to their specific situation.
With that said the next section reports on the key ethical considerations considered in the study.

3.8. ETHICAL CONSIDERATIONS

While all researchers need to conduct research ethically, qualitative enquiry has been singled out as having its own particular ethical dilemmas. When collecting data through human interaction, it is important to pay close attention to ethical parameters because there are "…inherent challenges related to the inductive and holistic nature of qualitative research" (Christians, 2007:19). Creswell (2010:21) who states that qualitative research "involves trust-based relationships between the researcher and participants" hence ethical conduct also amplifies this view and the researcher in any manner of means cannot overlook considerations. Having considered the advice and suggestions made by scholars such as Christians (2007); Creswell (2010) and Merriam and Associates (2016), I implemented the ethics strategy illustrated in the Figure 3.3 on the next page.

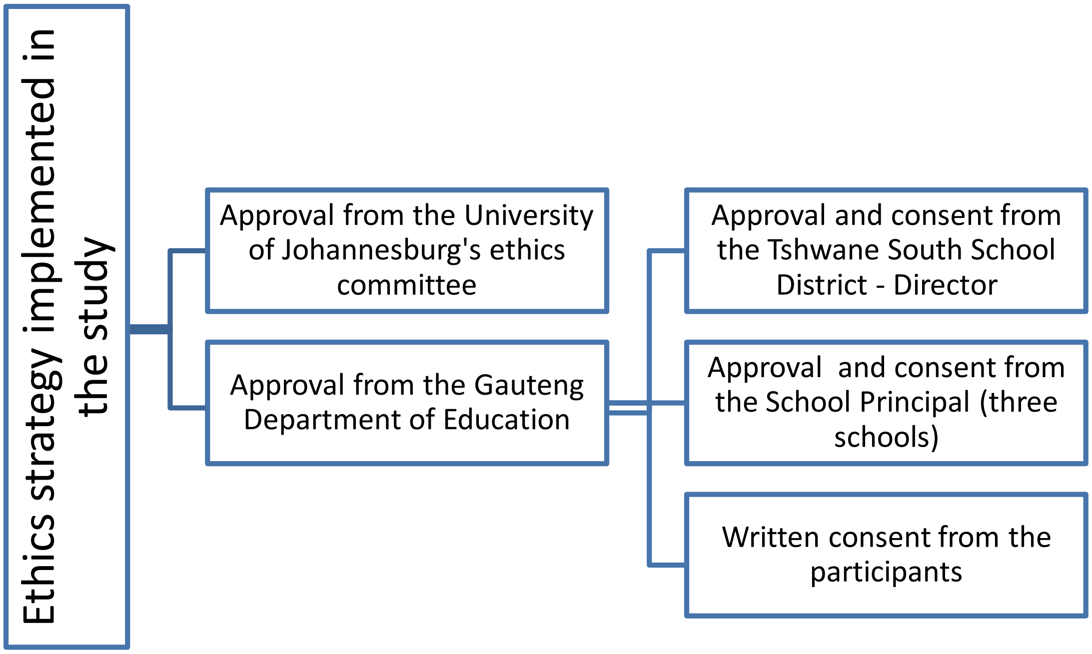


Figure 3.3: Ethics approval

A formal request for ethics approval as required by the University of Johannesburg was made to the Higher Degrees Committee (HDC) of the Faculty of Education. Ethical clearance was subsequently obtained from the HDC (Appendix A), with permission of the Gauteng Department of Education included as well. A formal letter requesting permission to engage in the research will be sent to the Gauteng Department of Education.

Research approval was obtained from the Tshwane South district and the four selected schools to participate in the study. In order to fulfill the information requirements, prior to the entry of the study the teachers and learners were informed of the purpose of the study, how it would be implemented and how the data would be used and analysed in this study. Informed consent was obtained from all research participants with participants being notified of the general nature of the investigation, their role in terms of time and effort, and procedures to be used to protect their anonymity and confidentiality (Mouton, 2004:47). The data collected during and after the study was handled in accordance with the confidentiality requirement to protect the participants at all times. To prevent identification of school, teacher or learner, the informants were allocated pseudonyms in the study.

I made every attempt to ensure that my interaction with the participants were non - intrusive, transparent, unbiased and open. At all times, I made participants aware that they could exit the study at any moment they so desired. Furthermore, I interacted with the participants in a humane, non-exploitative manner. Christians (2007:19) stresses the importance of “morality in everyday life and that researchers should pay special attention to this when collecting data from participants. In asserting that humans are ‘cultural beings’ with beliefs and values that inform how they relate to each other, Christians (2007:19) argues that “…ethical research is an extension of an individual’s moral stance”. His argument therefore alludes to the contextualised nature of research, i.e. there may be differences between your norms and expectations about what it means to do research versus those of the cultural community that you are exploring. In qualitative research, there is some degree of invasion of privacy (Silverman, 2000). This therefore raises a number of ethical issues that researchers must address in the course of the study. Some of the issues identified by Miles and Huberman (1994) were addressed in this study as follows: (see next page).

3.8.1. Informed consent

Before commencing with data collection, I informed the participants of the purpose of the research, as well as how the data will be collected from them. The data collection protocols were discussed with all participants prior to the data collection. I also briefed the participants about all the role players involved in the study and specifically what each participant’s role/s would be in the study. Furthermore, I forwarded each participant a consent form through email. An example of the signed copy of the consent form is attached in Appendix D (which is inserted at the end of this thesis).

3.8.2. Harm and risk

I ensured that no mental or physical harm befell any participant whatsoever. I ensured that participants were allowed to voluntarily exit the study at any time they wished. Participants were allowed the freedom and flexibility to either answer or not to answer follow up questions which I posed to illicit feedback. Hence participants were under no pressure to answer any questions which they felt was going to cause them mental harm.

3.8.3. Honesty and trust

I adhered to all ethical guidelines in the data collection process and analysis. I also made sure that undertakings of anonymity and confidentiality that were made to participants at the beginning of the study were adhered to throughout the data collection process.

3.8.4. Privacy, confidentiality, and anonymity

Due to the fact that the study involved face-to-face interviews, I could not ensure total anonymity. However, I took steps to ensure that anonymity and confidentiality to third parties was guaranteed. All identifying characteristics that could lead to the identification of the participants were removed before the dissemination of any information. Before the researcher started the interviews, participants where made aware that their personal names, position in the school and names of the schools would not be revealed. Therefore in the discussion sections of the report, the pseudonyms are used to refer to the participants.

Voluntary participation

I presented a brief to all potential participants at the beginning of the study and all the participants were given ample time to make a decision on whether to participate in the study or not. It was also made clear that the research was meant only for academic purpose and their participation was voluntary. Given the ethical considerations followed in this study, I ensured that the recommendation from Creswell (2003) to respect the privacy, confidentiality, dignity, rights, and anonymity of all participants was fully addressed in the course of the study. However, like any other study, there were a number of limitations to the study as discussed in the next section.

All 12 teachers selected met all these criteria and were practicing formative assessment. Six of the 12 selected teachers taught Grade 2 in the previous year and attended the AfL programme for the full duration of the programme in 2016. It was the district's decision to include only Grade 2 teachers in the AfL programme as Grade 2 teachers were often excluded in inservice professional development and training, while priority was gven to Grade 1 and Grade 3 teachers. Most of the district interventions were directed at Grade 1, being the entry into foundation phase and the Grade 3 being the exit grade.The selection of Grade 3 for the study was based on my assumption that the learners were previously exposed to the practice of formative assessment in the previous year when they were in Grade 2.

3.9. CONCLUSION

In this chapter, I presented an account of the design of the study and measures that I applied to argue its strength of design and methods. As a small sample case, the study could not claim much else except internal validity. To explore this claim I discussed a number of terms and approaches to exemplify why I would argue that the study is valid and believable, although not yielding generalisable findings. Nevertheless, I do argue that the reliability of the processes is strong and that the design could be replicated in other settings and even different topics. In the next chapter I present the results of the data analysis, giving glimpses of the processes and the participants rendering of their practice of formative assessment in the pedagogy of Grade 3 mathematics.

CHAPTER 4

ANALYSIS OF THE DATA OF THE STUDY

4.1. INTRODUCTION

In this chapter, I begin, with an explanation of the process that was followed in analysing the data. I then present the findings generated from the analysis of the data, which consisted of interview transcripts, field notes and video recordings of lesson observations and document analysis. Thereafter, I proceed to describe how each data source was coded by following the guidelines described by Saldana (2015). I then proceed to explain how the categories and themes were derived by referring to the guidelines provided by Patton (2002).

I followed an inductive approach to data analyses using a combination of thematic and content analysis (Creswell & Hanson, 2007; 2012) that were deemed feasible for the objectives to be achieved in this study. I integrated discourse analysis as described by Henning et al. (2004). The results of the analysis of data from the interviews, participant observation, and document analysis are integrated into a coherent and seamless narrative in the presentation of the findings.

Having considered the suggestion proposed by Merriam (1998: 180) that "it is important to do data analysis concurrently with data collection", I transcribed the data immediately after the interviews were conducted as data from each source was "…collected in order to obtain a holistic understanding of the data (Henning et al., 2004:89). I found this process to be useful as I became familiar with the "big ideas" emanating from the data and that responded to my research question, namely: "How do Grade 3 teachers integrate formative assessment in mathematics teaching?" This chapter is essentially a narrative of the process of composing the 'empirical' text; leading to the interpretation of themes in the context of the theoretical framework and the literature study in chapter 5.

4.2. DATA COLLECTION PROCESS

Table 4.1: Demographic information of the teacher participants in two focus group interviews

**(Pseudonyms were allocated to actual names of teachers and schools that were included in this study)*

	Name of teacher*	Name of primary school	School category	Highest qualification	Foundation phase – Teaching experience	Experience teaching Grade 3	Age of teacher
FOCUS GROUP A	Bela	Ellerines	Non Priority	B Ed (foundation	8 years	3 years	32
	Kayla	Ellerines	Priority	B Ed Honours in Foundation phase	24 years	5 years	45
	Sandy	Topclass	Non Priority	PGCE in foundation Phase	8 years	5 years	31
	Anna	Andes	Priority	B Ed – Foundation	12 years	7 years	33
	Sam	Shandu	Priority	The advanced certificate	13 years	6 years	35
	Nelly	Spot-on	Priority	Junior Primary diploma	16 years	8 years	38
FOCUS GROUP B	Elrie	Kendel	Non Priority	Junior primary Diploma	32 years	12 years	56
	Sue	Marlo	Priority	B Ed Honours in special ed	28 years	11 years	51
	Belinda	Rocky	Non Priority	MEd in curriculum studies	12 years	9 years	35
	Kami	Power	Priority	Advanced Certification in Education - Foundation	17 years	6 years	40
	Lara	Hilltop	Priority	Junior Primary Diploma	23 years	6 years	43
	Merl	Achievement	Priority	B Ed Honours Psychology	16 years	8 years	37

I commenced with the data analysis by organising and preparing the “raw data” of each data source separately (Henning et al., 2004). Thereafter, I identified segments of data that were responsive and aligned to the research question and sub-questions (Merriam, 2009:176). Data collection commenced with two focus group interviews comprising six Grade 3 teachers in each focus group (three teachers from “priority schools” and three teachers from “non- priority” schools). These teachers had variance attributes to their personal careers (Table 4.1).

All teachers in the study were female, aged between 31 to 56 years, with varied teaching experiences and professional qualifications. It is assumed that foundation phase qualified teachers with more years of experience will be more competent in teaching mathematics than the less experienced teachers. It was also expected that the newly graduated teachers, with a foundation phase qualification, would have current declarative and some procedural knowledge of mathematics teaching compared to their counterparts, but it was not the case.

Each focus group interview comprised six teachers from both priority and non- priority schools and yielded rich data on teachers’ understanding of formative assessment and their classroom practice. From the 12 teachers who were interviewed in the focus groups, I identified four teachers, Bela, and Elrie from non- priority schools; and Sam and Sue from priority schools for the purpose of classroom observation. I observed three consecutive mathematics lessons of each of the teachers in order to look for continuity and how teachers progress from one lesson to the next. This was significant in order for me to establish how formative assessment was enacted by the teacher participants. In total, I observed 12 lessons among the four teachers, which took place during the first two weeks of March 2017. At the time of data collection, all Grade 3 teachers within the District of Tshwane South were teaching the concept “place value” as this was scheduled according to the Annual Teaching Plans (ATPs). Observing the same topic, namely “place value” across all four teachers afforded me the opportunity to identify similarities and differences in the way teachers taught “place value” and how they integrated formative assessment using the same topic.

The observations took place in the morning hours during regular classroom teaching between 07:30 to 10:00 over a two-week period as indicated in Table 4.2.

Table 4.2: Observation work plan of the four teachers

School Category	Name of School	Name of Teacher	Observation dates	Time
Non-priority schools	Ellerines Primary	Bela	2017/03/06	07:45 - 08:45
			2017/03/07	09:00 - 10:00
			2017/03/08	07:45 - 8h45
	Kendel Primary	Elrie	2017/03/06	09:00 - 10:00
			2017/03/07	07:45 - 08:45
			2017/03/08	09:00 – 10: 00
Priority schools	Shandu Primary	Sam	2017/03/09	09:00– 10:00
			2017/03/10	07:30 – 08:30
			2017/03/13	09:00 – 10:00
	Marlo Primary	Sue	2017/03/09	10:30 – 11:30
			2017/03/10	10:30 -11:30
			2017/03/13	10:30 – 11:30

4.3. INDUCTIVE ANALYSIS OF THE DATA

I followed the approach of qualitative content analysis and where necessary integrated discourse analysis in salient examples of responses from participants. Following the suggestion of Merriam (1998: 180) to analyse data concurrently with data collection, I decided to transcribe the data immediately as the data was collected. While transcribing the data, I coded the data pages at the top right-hand corner to make it easier to identify the source of the data (Mykut & Morehouse, 1994: 127). For example, the FG1 in the code **FG1/Elrie/3** refers to the source of the data, namely Focus Group, Elrie is the pseudonym given to the interviewee and 3 is the page number of the transcript. I then read all the transcriptions repeatedly to familiarise myself with the data. I found this process valuable as it afforded me the opportunity to become familiar with the data before embarking on the analysis. I started by marking responses as units of meaning and proceeded from there to cluster codes that were conceptually linkable. Data was coded in three consecutive phases, which I ultimately documented as “levels”.

4.3.1. First level coding

For the first level of coding, I worked with the transcribed raw data and began to segment the data from the interview transcripts into meaningful units in grounded theory mode (Strauss & Corbin, 1998; Henning et al., 2004). In the first level of coding during the transcription process, I looked for recurrent ideas and metaphors that were apparent. In this phase of analysis, I examined what the participants said and also reflected on “how” the spoken/ written word shed light on their understanding of and practice of formative assessment. Therefore, when teachers said, “*During group teaching, we sometimes try to mix the groups so that stronger learners help weaker learners. When they help each other, they get it*”, I was able to ascribe a code) as “*Co-operative learning*”. I highlighted the units of meaning from the transcript and stated the ascribed code on the right-hand side in the comment section. I then labelled such talk as “Teachers’ awareness of strategies” as a marker. I followed the process suggested by Henning et al (2004). While working with the transcribed raw data and ascribed codes I came up with no less than two hundred and fifty codes. Realising that these were far too many and was in some instances too detailed, I thereafter looked for frequencies of the labelled codes across all data transcriptions.

I coded the data electronically by using the “review function – New Comment” embedded in the Microsoft Office Word 2008 software. Each chunk of data, paragraph, word or sentence that contained new meaning was coded using the “New Comment” function. The “New Comment” function automatically inserted a “text- box” on the right-hand margin with a line pointing to the chunk, word, sentence or paragraph.

I found the “New Comment” function very useful as the function:

- Allowed me to type in a word or phrase highlighting the essence of the unit’s meaning (Mykut & Morehouse, 1994: 129)
- Automatically listed the number of the unit. See example below:

Table 4.3, Table 4.4 and Table 4.5 illustrate examples of first level coding of interview transcripts, observation field notes, and document analysis respectively.

Table 4.3: Example of first level coding of an interview transcript: An extract from a focus group interview transcript

FG2/Nelly 10: If a child in class does not ask questions, does not show response or when I don't see him participating in class, then it worries me. "Is the level at which I am teaching this concept too high?" That is my first question. Should I bring it down to the child's level in order for him to participate in class? There are various reasons why children do not participate at that particular moment in class. Maybe he is sick, the level is too high, or he is just not interested at that particular point in time. But if it happens continuously, one specific child throughout the day, then as a teacher I really have to worry, there is something wrong there. I need to see then what kind of assessments, be it questions or whatever, be able to do to get this child to participate in the class. The	**Comment [P85]:** Values learners' questions **Comment [P86]:** Teacher evaluates her teaching **Comment [P87]:** Teacher reflection

Table 4.4: Example of first level coding of a classroom observation transcript: An extract from a classroom observation transcript

CO1/ Elrie3: When you were in grade two you used the cards to learn place value. Take out your flard cards. Sort out your cards, put all the hundreds, together, the tens together and the ones together. Put away the hundreds into your packet because we will only work with the tens and units today. *(Teacher observes learners sort out cards)* Show me thirty seven. *(learners show different cards, some 3 and 7, some 30 and 7. Learners lift up their numbers. The teacher asked the learners that showed 3 and 7 to stand up and asked them what it makes? Even before giving the teacher the answer, the learners quickly changed the 3 to 30)*	**Comment [P1]:** Prior knowledge **Comment [P2]:** Teacher's feedback **Comment [P3]:** Self regulated learning
CO1/ Elrie 3: What other ways can you make thirty seven	**Comment [P4]:** Encourages alternate strategies

I followed a similar process for coding the observation field notes (Table 4.4) and document analysis of district monitoring reports, teacher's interviews and lesson plans (Table 4.5) using the same content analysis. The data discussed in this section is analysed in the same way as explained by Henning (2004: 106). In Table 4.4 above, the **CO1** in the code **CO1/Elrie/3** refers to **Classroom Observation lesson 1**, Elrie refers to the pseudonym and 3 refers to the page number of the field notes/ transcribed data. The first three lines of the transcript in Table 4.4. related to the teacher's awareness of learner's prior knowledge from the previous grade.

Similarly, in Figure 4.5 below, the first level coding of a document, namely the district monitoring report, is illustrated.

Table 4.5: Example of first level coding of a document (An extract from a district monitoring report)

Name of school	Date of visit	Curriculum coverage	SBA coverage	Comments
Marlo Primary school	2017/ 06/ 20	40 out of 50%	36 out of 50 %	**CURRICULUM COVERAGE:** Coverage of topics is not sufficient. Only number, operations and relations are covered. Backlog on measurement, data handling, patterns and shapes and space. The folowing maths strategies not taught includes , number line, breaking down method and rounding off. **SCHOOL BASED ASSESSMENT** Backlog due to content areas and topics that were not covered . **TEACHER DEVELOPMENT** Maths workshops were not attended.

Comment [P1]: Monitoring of curriculum coverage

Comment [P2]: Monitoring of School based assessment

Comment [P3]: District's emphasi on curriculum coverage

Comment [P4]: Selective teaching of concepts

Comment [P5]: Monitoring of formal assessment

As illustrated in Table 4.5, I first highlighted the words or unit of meaning from the transcript (data) and then ascribed them. As indicated in the example in Table 4.5, the first line of the transcript, relates to the district's monitoring of curriculum coverage, hence I ascribed the code "monitoring of curriculum coverage".

After I had coded the interview transcripts from the focus group interviews, the classroom observation, document analysis and the interview with the district officials, I then proceeded to compile a list of the codes. I present the list according to each data source as follows: Table 4.6 is an extract from the list of codes for the interview transcript, and Table 4.7 is an extract of the list of codes derived from classroom observation.

Table 4.6: An extract from the composite list of codes derived from the transcript interviews of Focus Group A

FOCUS GROUP A: INTERVIEW CODING						
Participants	**Bela**	**Kayla**	**Sandy**	**Anna**	**Sam**	**Nelly**
What is your understanding of learning?	Learner reaches potential	Learner acquires new knowledge and skills	Unlock learners knowledge	Gets the right answer	Acquires new knowledge, skills, ideas	Can relate knowledge to other concepts
	Learning is facilitated by the teacher	Knows what steps to follow to get to answers	Occurs best through discovery	Learning is sequential	Builds confidence and behaviour changes	Sequential and progressive
	Takes place in stages- Piagets' stages	Is a cognitive process	Occurs through support-	Get the answers correct		An interaction between teacher and learner
				It's a process over time		Is a process
How do you come to know whether learning has occurred?	Assess using common standards	By checking whether learners remember	Through written assessments	Assess continuously as you teach	Observe and analyse learner's responses	Teacher ask questions
	Through questions	Assess learners at the end of the lesson	Formal assessments	Check if learners knowledge have changed after giving feedback	Self assessment	Learners ask questions
	Practical demonstrations	Assess everyday	Assess work covered in workbooks	Check learners responses on white board	Peer assessment	Analyse the errors of learners
	Observations	Assess according to their abilities		Observe learner's participation in discussions	Assess learners work against the criteria	
	Through learners' errors				Use the Traffic light strategy	

Table 4.7 on the next page shows the list of codes that were extracted from the 12 lesson observations of the four selected teachers. I used colour highlights to cluster together all related codes. For example, green was used to highlight codes pertaining to questioning; blue was used to identify codes that related to learner participation and yellow for learners' prior knowledge. I continued with this process until all codes were clustered. After coding the field notes and transcripts of the observations, I then listed all the codes into columns according to the four teacher participants as illustrated in Table 4.7. on the following page:

Table 4.7: An extract from the composite list of codes derived from the classroom observations

Classroom observations: List of codes			
Bela	**Elrie**	**Sue**	**Sam**
Numbers given human attributes	prior knowledge	teacher dramatises instruction	values singing in teaching
asks irrelevant questions	relates to learner's experiences	values repetition	uses language of teacher knowledge
questions are vague	teacher makes jokes	asks questions	learner participation
teacher answers own questions	values learners opinion	learner participation	answers own questions
Yes/ No questions	learner participation	peer learning	values games
tells learners what to do	acknowledges learners response	practical demonstration	values repetition
learner ask a question	provides clues to answers	use of resources	numbers placed in columns- uses
learner participation	learner teacher interaction	provides reasons	unclear instructions
Uses steps to teach	multiple calculation strategies	AfL strategies	vague questions
Uses language of teacher	teacher guides activity	self assessment using robots	teacher gives the answers
use of white board	learner verbalises thinking	draws on prior learning	misunderstanding of AfL strategy to engage learners
values prior knowledge	enjoyment of game	uses multiple strategies	values peer learning
teacher repeats questions	uses appropriate resources	introduces games	teaches procedure
learner uses dramatisation to	learner corrects teacher's error	draws to explain	practice self assessment
teacher does not acknowledge	encourages discussion	asks peers to explain	values prior knowldge
teacher centred learning	teacher answers question	individual practice	learner misunderstood question
lack of feedback	example follows feedback	encourages children to ask for	explains observation about a
teacher demonstrates	checks if learners are happy	provides whole class feedback	embarasses learner
lack of feedback to wrong	encourages thinking	uses multiple strategies	teacher's explanation is unclear
No differentiated opportunities	identifies misconception	uses white board	teacher lacks content knowledge
ask questions with an obvious			

4.3.2. The second level of coding: from codes to categories

Realising that these codes were far too many, I thereafter looked for frequencies of the labelled codes from data from both instruments (interviews and observations). Codes that shared similar characteristics were combined to form categories (Saldana, 2009). I applied the criteria of internal homogeneity and external heterogeneity as advanced by Patton (2015). Internal homogeneity refers to the extent to which data within a category fitted together. Conversely, external heterogeneity refers to the extent to which one category was clear and distinctive from the next (Patton, 2002: 465). I used coloured post-it notepad stickers for this. By moving back and forth between the data, codes, and categories, I was able to verify the meaningfulness and accuracy of the categories and the placement of the data in the categories (Patton, 2015: 466). I used comparisons to build and refine categories, which resulted in some categories being modified during the process (Henning et al., 2004).

Through this method of coding and categorising, I was able to compose 16 categories. Table 4.8 provides a summary of the refined codes that were grouped together to form the different categories.

Table 4.8: From codes to categories

CATEGORIES DERIVED FROM CODES	
CODES	**CATEGORIES**
Teachers view learning as being built on existing knowledge	1. Teachers have some awareness of learning as being a process
Learning is about building on new knowledge, skills and attitudes	
Knowledge gaps from previous years	
Teachers' awareness that learning is hierarchical	
Teachers value the importance of structure through rules and steps to help learners remember	
Learning is about meeting the curriculum standards	2. Teachers are fully aware of curriculum requirements and standards
Teaching is controlled by curriculum requirements and departmental guidelines	
Teachers are aware of the hierarchical structure of mathematics content	
Teachers see little value in the curriculum's formal assessment tasks in enhancing learning	
Learners enjoy counting rhythmically and in sing song fashion	3. Learners interest and involvement in learning increases when learners are actively involved.
Learners are attentive when games are used in teaching	
Meaningful learning when teachers engage learners in practical demonstrations	
Learners engage in cooperative learning through games	
Children remember math terminologies and sequences through games	
Creates a collaborative classroom climate	
Learners are free to ask peers for help	
Learners are encouraged when their efforts are acknowledged	
Teachers value the importance of structure through rules and	4. Teachers have some understanding of

steps to help learners remember.	the complexities of learning
Teachers believe in the notion of " learning style"	
Teachers have some awareness that learning pace differs among children	
Teachers view individual practice as important in learning	
Teachers acknowledge the role of remembering in learning	
Teachers value repetition in learning	
Teachers acknowledge the importance of identifying learning gaps in learners	5. Teachers acknowledge the importance of knowing the learners as a precursor in teaching mathematics
Teachers have some awareness of learning styles	
Understanding learner diversity is a precondition to teaching	
Teaching is meaningful when linked to learners' experiences	
Teachers use some strategies learnt at the AfL professional development programme	6. Teachers have some awareness of strategies to find out if learners have learnt something
Teachers show some awareness of error analysis	
Teacher's limited use of probing	
Teachers seldom encourage learners to use practical demonstrations	
Teachers attach more value to the answers rather than the process used in getting the answer	
Teachers have some awareness of the role of self-assessment in learning	
Formal assessment is teacher paced	7. Teachers see little value in summative (formal) assessment to assess children's learning.
Formal assessment is seen as evidence for department	
Unfair to learners as learning pace differs	
Forces teachers to teach only what's being assessed	
Reduces quality teaching time	
Scripted lesson does not allow for reteaching	8. Teachers limitation and usability of formative assessment in improving learning
Annual teaching plans to monitor pacing of content	
Overemphasis on curriculum coverage	
Limited opportunities for learner interaction	
Limited opportunities for problem solving	

Limited feedback to learners	
Incoherent development of concepts	9. Teachers have limited conceptual knowledge of mathematics concepts and how to communicate them clearly and coherently in instruction
Difficulties in translating teacher knowledge to curriculum knowledge	
Lack of conceptual knowledge	
Teaching deviates from the outcomes of lesson	
Teachers show reliance on prescribed lesson plans	
Overemphasis on procedural knowledge	
Teachers limited use of problem solving	
Teaching instructions lack clarity	10. Teachers have limited general pedagogical knowledge (GPK)
Teaching is teacher centred	
Teachers limited use of strategies to engage learners	
Teachers questions lead to superficial learning	
Limited use of multiple strategies	
Limited use of resources in teaching	
Teachers provide solutions instead of guiding learners towards the solutions	11. Teachers shows awareness of feedback but learner support is ineffective
Limited use of individual feedback to learners	
Teacher ask other learners to give the correct answers	
Teacher seldom follows up on feedback	
Teacher does not acknowledge correct answers	
Participation limited to a subgroup of learners	12. Teachers' limited use strategies to engage learners in learning
Teachers value peer learning	
Learners show willingness to help others	
Teacher occasionally ask for learners opinion	
Limited opportunities for learners to ask questions	
Learner verbalises thinking	
Learner ask questions	
Teacher is curriculum compliant	13. Professional aspects of being a teacher are valued
Teachers value their participation in CoPs	
Values teacher collaboration within school and through	

school networks	
Difficulties in translating teacher knowledge to curriculum knowledge	
Selective implementation of strategies	
Teachers express lack of school and District support	
Numbers given human attributes	14. Teachers use analogical reasoning in explaining concepts to learners in a haphazard and often non-coherent way
Numbers given a house	
Talks about rules of house	
Number line referred to as nieghbourhood	
Links learning beyond experiences/ interest of learne	
Teacher ask question, then answers own question	15. Limited use of high quality questions to find out about children's learning
Ask multiple questions without response time	
Teacher's formulation of questions are unclear	
Questions limited to Yes/ No answers	
Questions does not elicit learners thinking	
Teachers ask questions not related to outcomes	
Limited thinking time for learners	
Teacher repeat the same question when there's no response	
Questions are not varied	

4.3.3 The third level of coding: From categories to themes and patterns

The use of multiple sources of data collection enabled me to make comparisons and connections between the patterns that became evident during the data analysis. These multiple sources of evidence (see Figure 4.8 for example) were used to confirm the emerging findings (Merriam, 1998) and provided corroborating evidence (Creswell, 1998). Multiple data sources afforded me the opportunity of forming a holistic picture of the findings (Henning et al., 2004). Once all the data sets had been coded and categorised, I looked at the relationship in meanings between the categories in relation to the research question (Henning et al., 2004: 106).

Following this process, I observed that themes were beginning to emerge from these categories. I also considered how these categories linked to my prior knowledge of the research under investigation through the literature review (Henning et al., 2004).

I was satisfied that the data I had collected was sufficient in addressing the research question and that there was no need for further data collection and analysis (Henning et al., 2004).

Table 4.9: An example of a category showing triangulation of data from different sources

Category	Refined codes: Interview transcripts	Refined codes: Classroom observations	Document analysis
Teachers have some awareness of the complexities of learning	Learning is a sequential The pace of learning differs learning is dependent on prior learning learning styles vary Talks about contextualising learning	Learning is dependent on prior knowledge integrates various teaching approaches Requires individual instruction Teachers use procedural methods Use of repetition	School monitoring report The absence of individual learner support programme Error analysis Monitoring of ATPs- report on curriculum coverage

From that point forward, I looked out for themes that ran across the categories and came up with six themes as indicated in Figure 4.1. This was an iterative process as I found overlaps between some categories. Figure 4.1 depicts the process I followed using the data in the study to construct the themes, which is used in the discussion of the inquiry. From here on, I identified themes that ran across associated categories and hence came up with six themes as indicated in Figure 4.1. I organised codes into categories and then categories into themes by using post-it notes. This enabled me to constantly revise and reorganise the codes and the categories where they fitted best I then read through the codes carefully once again to see if the codes were not repeated and whether it matched the categories.

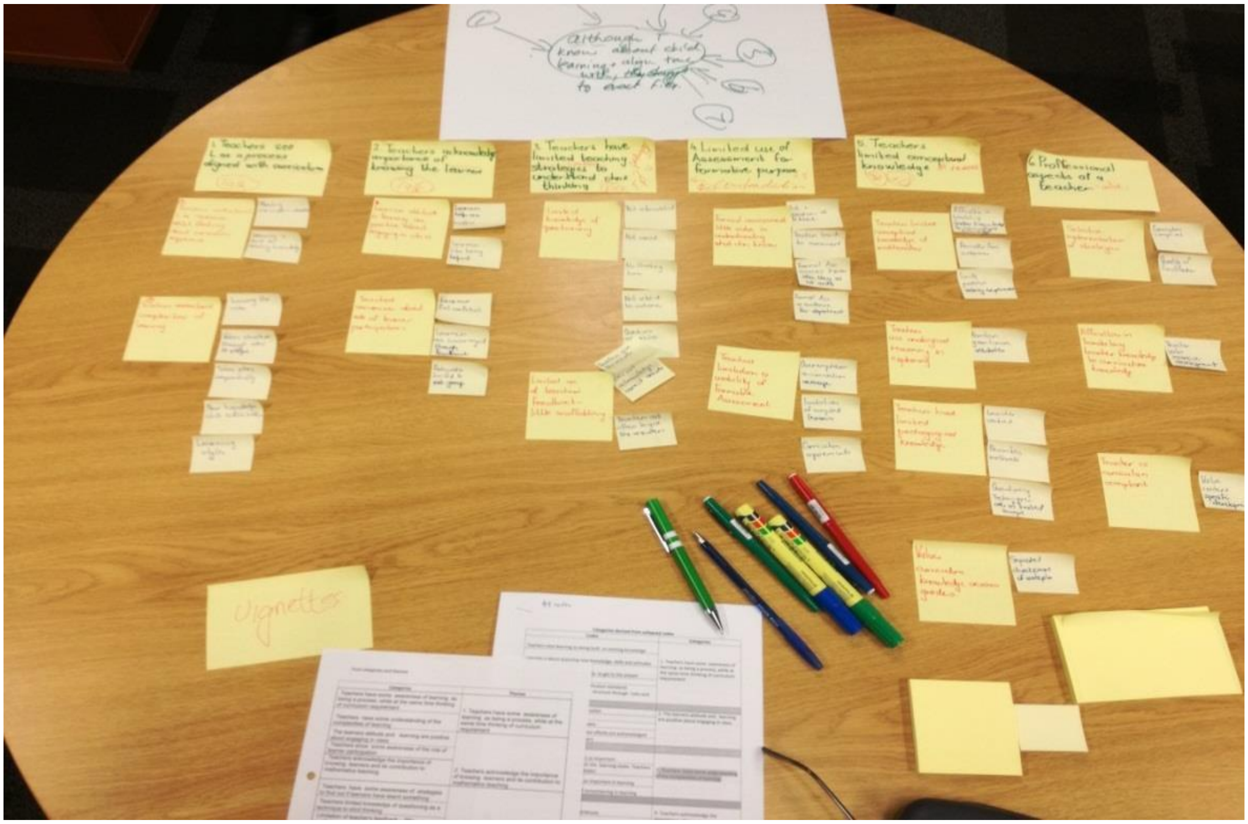


Figure 4.1: Grouping categories into themes

I finally decided on the following grouping of the categories into six themes as highlighted in Table 4.10.

Table 4.10: Themes emerging from categories

Categories	**Themes**
Teachers awareness that learning is sequential	1. Teachers have some awareness of learning as being a process, while at the same time thinking of curriculum requirement
Teachers are aware of the curriculum standards and requirements	
Teachers have some understanding of the complexities of learning	
Learners show an interest in learning when they are actively involved in learning	2. Teachers are aware that learners' engagement in class contributes to enhanced learning
Teachers use a variety of strategies to engage learners in a collaborative learning	
Teachers acknowledge the importance of knowing learners and its contribution to mathematics teaching	

Limited use of high-quality questions to find out what children know	3. Teachers have some awareness of strategies to find out if learners have learned something
Teachers see little value in using formal assessments tasks to assess children's learning	4. Teacher's limitation and usability of formative assessment in improving learning
Teachers show some awareness of feedback, but learner support is still a challenge	
Teachers have limited conceptual knowledge of mathematical concepts and how to communicate them clearly and coherently in instruction	5. Teachers have limited conceptual knowledge of mathematical concepts and how to communicate them clearly and coherently in instruction
Teachers have limited general pedagogical knowledge (GPK)	
Teachers use analogical reasoning in explaining concepts to learners in a haphazard and often non-coherent way	
Teachers value professional development	6. Professional aspects of being a teacher are valued
Teachers value their teacher agency	
Teachers value learning in professional learning communities	

Thereafter I scrutinised the six themes to discern common concepts, with which all the themes could cohere and into which the six themes would 'fit' as if in a *conceptual pattern*. The central finding is that, although teachers know about children's learning and can align their teaching, they struggle to enact formative assessment. This pattern emerged around the themes as depicted in Figure 4.2. on the next page.

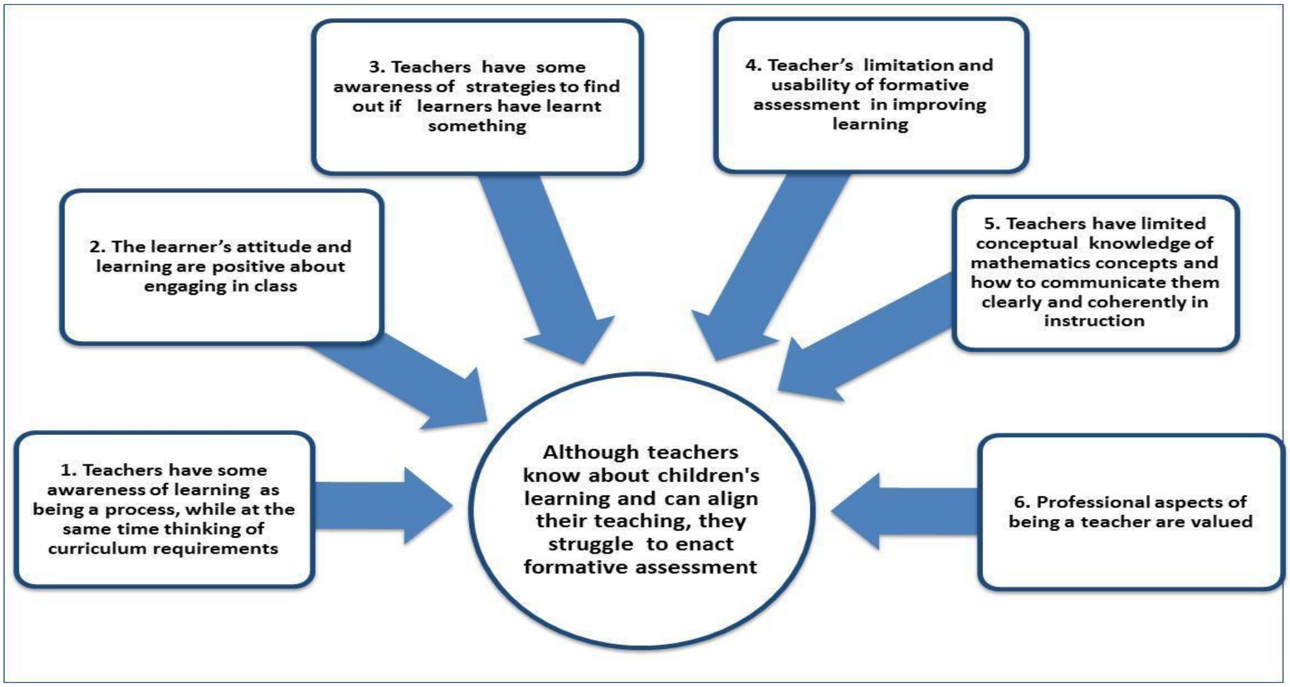


Figure 4.2: Patterns of the main finding

The flowchart in Figure 4.3 below is an example of how I coded the data from one theme 'backward' to codes. I used this strategy as one way of strengthening the reliability of the process of analysis as an example.

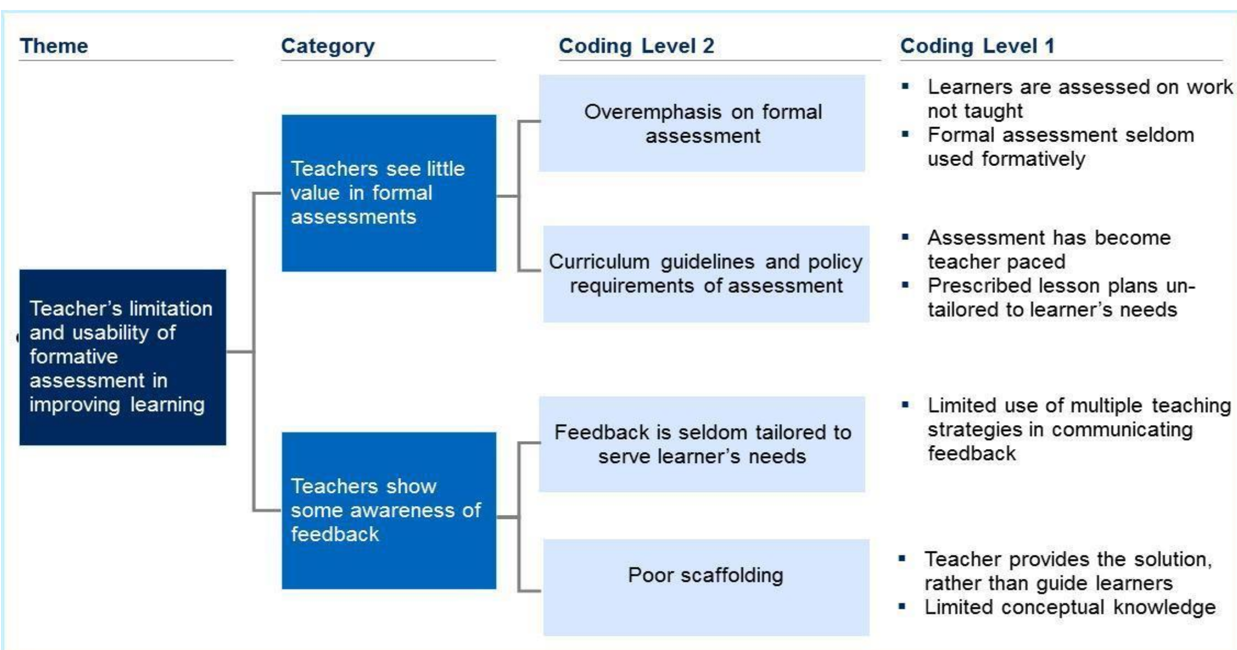


Figure 4.3: An example of a flowchart from one theme backward to codes.

One may argue that while teachers know about how children learn and have some knowledge about AfL strategies, they seem to struggle to integrate these strategies in mathematics teaching. My argument is that while this may be true, the AfL professional development programme which teachers attended may have contributed to teachers' consciously attempting to use the strategies. During the lesson observations, I noted that each day teachers deliberately introduced more and more strategies that appeared to be efforts to practice formative assessment. The introduction of the strategies may be attributed to the "Hawthorne effect," a metaphor that is used to explain the positive results during the lesson observations (Wickstom & Bendix, 2000). Wickstom and Bendix (2000:1) assert that the "Hawthorne effect" provides an explanation to many phenomena, "not only unwitting confounding of variables under study by the study itself but also behavioural change due to an awareness of being observed and active compliance with the supposed wishes of researchers because of special attention received. It was interesting to note that even those teachers who did not attend the training, nonetheless, tried to use AfL strategies to engage learners. During the post observation discussions, the participants mentioned that ever since they had been involved in the study, their instructional practices have changed.

One participant succinctly expressed this sentiment:

> *"Since being part of the study, I no longer teach the way I used to. It has changed my whole teaching. I now start to think more deeply about what I need to do to get the children thinking in mathematics. In the past, all I did was teach just to get the work done*".

The data that supports the claim I make, show that although teachers used innovative AfL strategies in their instructional practices, such as "robots, exit tickets, lollipop sticks, whiteboard" and "call a friend strategy" in mathematics teaching, these strategies were applied technically and not integrated meaningfully into the mathematics lessons.

4.4 PRESENTATION OF FINDINGS

In this section, I present the findings of the study. In the presentation, I reflect on the participants' perspectives, classroom observations and document analysis by quoting extensively from the raw data to provide an account of the voices and perspectives of the role players. I also present descriptions of significant episodes observed in the form of vignettes. I present the findings under sub-themes within each of the six broad themes.

4.4.1 Theme 1: Teachers have some awareness of learning as being a process, while at the same time thinking of curriculum requirement

Teachers' awareness of learning as a process emerged as a strong theme and is presented under the following sub-themes:

- Learning is process driven
- Teachers' awareness that learners' prior knowledge is a precondition to learning
- Teachers' understanding of the complexities of learning
- Teachers' awareness of curriculum requirements

Learning is process driven

Sue viewed learning as a continuous life-long activity that continues not only in the same grade but also across other grades and subjects as expressed in the following utterances: "*Learning doesn't take place, maybe 30 minutes and then it is gone, maybe in Grade 1 and then it's forgotten*". Sue added that "*learners acquire knowledge relevant to the the grade and beyond*". Sue also stated that learning happens all the time in different contexts, for instance, "*…what you learn in mathematics, you apply in natural science, social science. It doesn't take place only in one subject and then that's it*". This view of learning influenced Sue's formative assessment practices. Sue's daily lesson plans included activities based on a revision of previous grades work or the work that was taught earlier in the year. Sue remarked "*with the little ones, you reteach by moving back to be able to move your learners forward*". Consequently, Sue constantly linked the new knowledge to learners' prior knowledge during her classroom practice. To deepen learners' understanding, she also integrated mathematics with other subjects of the curriculum.

This afforded Sue the opportunity to understand learners' thinking as they transferred their knowledge to related context. The study also showed that the majority of teachers are aware of the hierarchical nature of learning as evidenced in the following utterances of both Sue and Kayla respectively: (FG2/ Sue/4) "*With mathematics, there are steps that children need to follow to get to the answer. It's not like in a story where you can start from any point, yet still reach the end of the story. It's about following a sequence of steps*"; and (FG1/Kayla/4): "*Learning is like a pyramid. The structure they [learners] need to follow is certain steps before they [learners] can go to complex concepts. Then it goes with levels. So in order for them [learners] to reach another level, it means they [learners] must first understand the basic level*".

Kami expressed a similar view as she stated (FG2/ Kami/6): "*To get them [learners] to understand the problem, I break the problem to a simpler problem. If you tell the learner to count in twos from zero to 100, it sounds like a big task. Therefore, I try to find ways to master counting in twos; like using a smaller number range, next using concrete apparatus to group in twos. In this way, they can master the concept. Once they get the idea with a smaller number range, then they can do it with bigger numbers. They will tell you that only numbers zero, two, four, six, eight are used when counting in twos. This is one way to help them to remember counting in twos involving bigger numbers*". Kami is of the view that learners can be supported by mastering concepts using smaller number range as they discover patterns and ways of remembering which could be applied when they work with bigger number ranges.

All the participants alluded that many learners lack the foundational knowledge, which they should have acquired from the previous grades. Both Sue and Kayla maintained that learning is sequential. Therefore, in order for learners to be able to grasp Grade 3 mathematics, they need to understand the foundational skills and knowledge from previous Grades. As one participant stated (FG2/Sue/5): "*So there is no way that when they go to Grade 3, they will be able to follow, because the problem is there in Grade 1 and Grade 2".* Two participants succinctly expressed their frustration at having to teach Grade 1 and 2 work in Grade 3. (FG2/ Elrie/6): "*It's horrible to say that sometimes the basics are not even there. Counting is not there. Now I find myself teaching Grade 2 work in Grade 3, sometimes even Grade 1 work. I think if we get the basics in place, it will make our job as Grade 3 teachers so much easier*" and (FG2/ Bela /7):"*If that base is not there,* *in Grade 1 and Grade 2, we actually cannot go on, because Grade 3 is actually an extension of Grade 1 and Grade 2 work. In Grade 3, we are actually building on what they have learned in Grade 1 and Grade 2 and then in Grade 3, we continue with that base. So I actually have to go back and that makes it difficult for me as a Grade 3 teacher, to get that child on that standard to have the base knowledge*".

Sue subscribes to the notion that learners follow developmental stages in their learning; therefore, it makes sense that any knowledge gaps in the preceding years will hinder the progress in later years. Sue expressed this view as follows:

> (FG2/Sue/9) "*Children follow a developmental path as mentioned by Piaget. A child cannot start by standing and running. The child must first crawl, stand, walk and then run. The child cannot jump those steps. So even in mathematics, the child follows certain steps in learning. It really works for me because the learning difficulties get fewer the more I focus on the common basic skills and knowledge that learners require for other concepts. Once learners master this basic knowledge, they are more successful in learning".*

The above responses allude to the fact that Grade 3 teachers spend much time teaching the content of the previous grade's curriculum. The response suggests that teachers are aware that learning is hierarchical and is dependent on specific skills; and specified ordered and intellectual capabilities to facilitate higher learning. Teachers are also aware that specific subordinate skills and knowledge are a prerequisite for learners to develop an understanding of more complex.

Learner's prior knowledge as a precondition to learning

The study also showed that majority of the teachers acknowledged the importance of learner's prior knowledge and the inter dependencies of related concepts in the acquisition of new knowledge. To illustrate this point, Sam explained the importance of learners having a sound understanding of fractions as a precondition to learn about time.
(FG1/Sam/14): "*Children must know about fractions. When you cut something into two equal parts, you get half, then when you cut a half into two equal parts, you get quarters. So it means you must go back and teach them about fractions. You must know which*

concept leads to another. If they do not have the concept of fractions, it means they will not be able to do "time". Another participant, Elrie, highlighted the importance of providing learners opportunities to apply their knowledge in varied contexts to identify knowledge gaps (FG2/Elrie/17) "…..*Taking the hundreds, tens and units, out of place value, you can use that knowledge to teach money. Taking it out of money, using it to teach time in terms of minutes and hours. Using it in other contexts broadens their existing knowledge of hundreds, tens and units. When he [learner] demonstrates to me that there are 120 minutes in two hours, then I can see that he has learned something. To me, learning has then taken place*".

Elrie is of the view that when children apply their learning in different contexts, it not only improves learners' understanding, but also provides an opportunity for the teacher to identify where the learner is struggling. Elrie also stated that concepts can be reinforced through an integrative approach, and applied in different situations throughout the school day. FG2/Elrie/ 15: "*You do not only use the mathematical concept in the maths period only. You use it in life skills, in teaching the timeline. In addition, when you do your language, there are things of maths that we use in the language. It is not a subject on its own*".

Teachers' awareness of the complexities of learning

The participants showed an awareness of the complexities of learning arising from the notion that learners are diverse and therefore need different ways of teaching. Teachers cited learners' varying abilities, diverse learning styles, and diverse experiences as central to the complexities of mathematics learning. The problems associated with teaching learners' with diverse learning abilities was exemplified by Sam as follows: (FG1/ Sam/23) "*We have a support class, where learners of similar abilities are brought together. However, even within similar levels, they are so different. They have difficulties with different concepts. You may find that in a class, some learners grasp, but five learners do not*". Sam posits that even within a homogeneous ability group of learners, there exist differences among these learners, which the teacher needs to consider when teaching mathematics. Similarly, Elrie explained how she adapts her teaching to accommodate the learning needs of individual learners as evident in the following utterance: FG2/Elrie/9: "*Through my many years of experience, I learned how to "chop and change" my teaching* *according to the learning needs of every child in my class. Some learners are slow and others faster. Every year is a new challenge with new learners and you have to adapt to the class you have in front of you.*"

Teachers awareness of multiple teaching strategies to accommodate varying learning needs were evident in the following responses: (FG1/Sandy/9) "*I had no idea how to assist struggling learners until I discovered that in class it 's not one size fits all. These learners are in need of alternative methods of teaching. As a teacher, I had to think of different ways of teaching to reach all learners*", and (FG/2/Sue/ 6) "*Some [learners] learn just by keeping quiet. These learners simply receive the knowledge, some by talking, making conversations with others, some by looking at something and remembering it and some by listening to others. We need to take this into consideration that children learn differently.*" Both Sandy and Sue alluded to the need to have different strategies at hand when teaching to respond appropriately to learners' needs.

The value of practical demonstrations in teaching mathematics was expressed by Sue, Elrie and Sam: (FG2/ Sue/19) "*Children learn and remember when they practice on their own, rather than being told what to do. It's easier for them to remember what they have done than what they are told to do*" and (FG2/Elrie/20): *"So if you are doing mathematics, let's say you do fractions, not just explain the fraction, show it to them, cut the bread in the class, they must do that themselves as well. They can also cut paper; they must also do it so that they can understand it;* (FG1/Sam) "*We don't really know if learning has taken place. I see this with the learners. You teach, you assess, and you think they acquired the knowledge, then they pass, they go to the next Grade. The next teacher complains that these children do not know the concepts. Yet we know it was taught*". Kami and Lara further stated that learners respond differently to the way they are being taught, (FG2/ Kami/23): "*You find that some learners acquire the knowledge while some don't.* (FG2/Lara/26) "*You will find that the way you put the knowledge across may be grasped by some and not by others*".

Problem-solving was another strategy that was conceived of as being central to understanding mathematics. In most of the discussion with the teachers, problem-solving was linked to children's experiences and to what was familiar to learners to make learning meaningful. Elrie believed that learning takes place when learners are able to solve problems and when they are able to apply the concepts in other situations to solve problems. Both Sue and Elrie shared their experience by citing the following examples:

FG2/Elrie/32) mentioned that in order *“to get learners to estimate, I posed a problem. ’Mommy sent you to the shop to buy bread and milk. How much is she going to give you? ’They had to think and one learner said, ‘bread is R12’ and another learner said ‘bread is R10’. They had a whole discussion on what is the price of bread at that moment. In addition, the same with milk and at the end we said okay, fine, let us say milk is maybe R17 per litre. ‘So if mommy gives you R20, will that be fine?’ and we did that with the bread. Some bread will be R13 and some of the bread is only R8. So we actually agreed with the one that is the most and we said, okay, fine, that is also maybe another R20. So mommy must give you maybe R20 and another R20 and what will that make? Therefore, mommy must give you R40 for in a case, so that is an estimation.*

Then I asked them, what are you going to do with the change? They said, “I can buy a packet of chips with the change or I must give it back.” Therefore, that is teaching mathematics in real life. That is what real life is all about. You go to a shop; you do not know what your bill is going to be at the till”

FG2/ Sue/24: “*If I’m teaching place value, i.e. grouping in tens, I use real life story so that my learners understand. I tell them that we are going to count how many learners in the class. We start by first counting the whole class in ones. Then we count in fives to make groups of tens. I demonstrate this with the learners practically. I will ask them which is quicker. If they can say, “counting by grouping in tens” then it means I have laid the foundation for counting in tens in the class”.* Both these examples allude to the importance of authentic learning experiences in promoting conceptual understanding. Moreover, Sue believes that learners learn best when they understand when and why they need to use a certain strategy. This was evident in Sue’s lesson. Sue started her lesson on counting by revising unitary counting. She asked learners to count all the counters in an ice cream container in ones. Next, she asked learners to count in twos by making groups of twos. She then asked learners to count in tens by making groups of tens. She then asked the learners which method they liked and why? Most of the children stated that they liked counting in tens, as it was easier and quicker. Sue asked “When will you use the strategy of grouping in tens to count? When will your group in twos?” Sue then explained that counting in tens can only be done with a large number of counters, but if the objects were fewer, they could count in twos, threes or fives.

Sue then grouped learners into fives and gave each group of learners a box of counters together with some polystyrene cups to be used to make groups of tens as shown in Figure 4.4. She asked learners to count out the counters using the quickest method. Learners used different strategies, some counted in ones, some in twos to make groups of tens. Each child in the group had to count the number of groups of tens they made. In one group, there were eight tens and five ones left over. They then counted the groups of tens, said that there were 80, and counted on the ones to get the answer 85.

The children discovered that counting in twos and threes to make tens, was a much more efficient strategy than unitary counting.

Figure 4.4: Photo extracted from classroom observation

The activity on counting then led to estimation. Sue asked the learners to write on their whiteboard the estimated number of colourful magnets (represented smarties) placed randomly on the chalkboard. Each learner had different answers. To find out whose estimated answer was the closest, the class needed to count out the magnets. Sue helped the children to count by drawing five circles on the board, which represented the cups used in the first activity as shown in Figure 4.5. She demonstrated how to make groups of tens. She asked children to help her count aloud as she moved one magnet at a time into the first circle group until she had 10. She then asked a learner to make the second group of tens as she had done. Sue then asked, "*How can we do this quicker*," One learner said "*take two at a time,*" Another learner said, "*Call a friend to help*". One learner put 12 magnets into the group instead of ten. Sue asked, *"Is that right. Count again*". Immediately the learner removed two counters. When all the counters were put into groups of tens and the units left aside, the teacher went back to talk about units. "*How many digits do units have? What numbers are the unit numbers? Why can't I put this into the group of tens?*" The teacher asked learners to write down "*How many tens*". One learner wrote 50. Sue then explained what a ten is. The learner could then answer correctly that there were five tens. The teacher then explained to the learners that they had learned how to group in tens which was one of the learning intentions.

Sue then explained that another learning intention is to build up numbers. She stated "*This means that we must add the tens and units together"*. She pointed to groups of tens as learners counted. They then counted the nine counters in ones. Sue showed how it is written i.e. 50 + 9 = 59 on the board. Sue used a yellow card for 50 and a red card for nine. She explained that when it is put together, it makes 59. She placed the 50 cards first and then the nine over the 0 in 50 to get 59.

The multiple teaching strategies which Sue alluded to during the interviews were observed in her classroom practice. Sue created opportunities for learners to be actively involved in the learning through practical demonstrations. Learners discovered for themselves that grouping to count was a more efficient method. Two teachers in the study highlighted the role of memorisation in learning. Sam taught the learners a song that had repetitive words and used dramatisation to help learners remember the greater than and less than signs, "*Close, close (Pointed end) to the small number. Open, open to (used two hands to show open mouth) the big number, close, close to the small number*. *When it is closed, the end points to the small number. The open side is towards the big number".*

Figure 4.5: Photo extracted from classroom observation

Teachers' awareness of the curriculum requirements

Another finding was that teachers are aware of how children learn and what learners are expected to know based on the curriculum requirements. However, their teaching is constrained by the prescribed curriculum, which does not take into account learners' diversity: (FG1/ Nelly/29) "*that is where the problem lies, to deliver the same curriculum to all learners, yet they have such diverse abilities*; (FG2/ Elrie/14) "I*t seems like we have to go back to multi-level teaching. The stronger learners are always the ones that you can feed the curriculum as it is and they will be fine. In addition, the weaker learners are the ones you have to break it down and you need to find ways to teach them. As soon as you realise the child is not going to get this, you now have to think about "how am I going to teach this to the child. It's really not easy*". Elrie acknowledges the need to use multi-level teaching strategies to accommodate learners with diverse abilities but at the same time states that it is not an easy task.

In response to Elrie, Sandy stated (FG1/Sandy/17) "*its [multi-level teaching] easier said than done. We are working with Grade 3. Our work tempo is so, so, so busy, we are really putting it like this …pumping the children with knowledge to get through the whole CAPS,* *just giving them what they need according to policy. In the end, all that you worry about is trying to get through it and not trying to teach to make them learn*".

Another challenge experienced by teachers is the knowledge gap among Grade 3 learners arising from the previous years, which makes it difficult to mediate the Grade 3 curriculum. This is evident in the following utterance: (FG2/ Dona/13) "*Our children in Grade 3 are struggling because they were not taught these foundational concepts in Grade 1 and 2. The problem lies somewhere in the previous grades*".

Teachers' misunderstanding of the use of the Annual Teaching Plans (ATP's) also inhibited their formative assessment practices. Teachers adhered rigidly to the ATPs irrespective of the context of the classroom. This finding was corroborated by the subject advisors' observations: "*Teachers use the ATP as a lesson plan, instead of a tracking document*". Strict adherence to the ATP has prevented teachers from providing timeous support to learners who have not grasped the concept, leaving many learners behind. Elrie expressed this sentiment as follows: (FG2/Elrie/25) "… *In addition, if you know there is trouble with addition, now in the first term, you just leave it and move on. There is no time to support the slow learners. So in the second term, when you are doing addition again, you go back to first term's work and explain that work again*". Upon further probing, Erie stated that although she tries whenever she can to provide timeous support, the amount of time spent on the support is limited because she has to keep to the pacing of the ATP's. Three participants, Elrie, Kayla and Nelly expressed their frustration regarding the use of the ATP's as follows: (FG2/ Elrie/34) "*There is just no time to go back and reteach. If you do this, then you are going to lag behind in your ATP's. So the poor learners just remain behind*"; Kayla: (FG1/Kayla/ 27) "*And you end up doing it, even if it is not on your plan for that day, because really it bothers you Then you need to check along the way where you can just squeeze it in your ATP*;" and Nelly: (FG2/Nelly/ 34) "*That is actually where you leave the ATPs aside. Then you leave everything aside and say today I am just focusing on that. At the end you are getting behind, you do not know where to really start teaching again.*"

The data presented under this theme suggests that teachers are aware that learning is a process with its own complexities and at the same time, they are aware of the curriculum requirements. They are aware that they have to help every learner meet the curriculum requirements, but tend to struggle with adapting the content, the process and the product of the curriculum standards. Although teachers have mentioned that they value the importance of differentiated instruction in helping learners learn, this was not evident in their classroom practice. The curriculum demands make it difficult for teachers to apply differentiated. Every learner in the class has to meet a set of standards in the mathematics curriculum and has to be assessed according to the standard assessments

Teachers also expressed their frustrations with regard to the curriculum coverage model and the prescribed lesson plans which stifled their individuality. This sentiment was expressed in the following utterances: (FG1/ Sam/34) "*Our teaching has become ATP [Annual teaching plan] paced, not learner-paced. If we are behind with the assessment, we must account for this. Then you are in the spotlight for not complying*"; (FG1/ Nelly/34) "It seems like we are teaching and assessing for the officials"; (FG1/ Anna/23): "*We know about the policies… That we need to accommodate every learner. But we don't consider the policies any more*". In addition, the teachers also alluded to the difficulties they encountered in administering the common formal assessments with all learners. In most instances, the formal assessment task is set beyond the abilitiy level of the slow learners. This sentiment was succinctly expressed by Elrie as follows: FG2/ Elrie/ 27: "*I try to assess when the majority of learners are ready, but it's not possible. To keep to the curriculum requirement, we end up assessing learners even though learners are not ready. Why can't we just assess learners according to another level, a level they are currently working on? It would be so much more useful*".

4.4.2 Theme 2: Teachers are aware that learners' engagement in class contributes to meaningful learning

A prominent finding that emerged in the study is teachers' awareness that learners' engagement in class contributes to enhanced learning. During the focus group interviews, all the participants alluded that learner participation is central to learning. This was confirmed during the lesson observations where teachers used a range of strategies such as: call a friend; popsicle stick; peer learning; group work and quizzes, games, and songs to engage learners in collaborative learning.

Sue used the "Call a friend" strategy to promote co-operative learning as shown in Figure 4.6. Each learner had their own cell phone (See Figure 4.6 below). Learners used the cell phone when they had a problem to call a friend for help. The following vignette explains how Sue engaged the learners using "Call a friend" strategy. Sue asked the learners to count out lollipop sticks from a packet and to show the number of the sticks using their flard cards. Each learner had his or her own set of flard cards. One learner (Sipho) who counted 55 sticks raised his cell phone and said, "*I need two number fives. I have only one number five card*". Sue then asked the class "*Who has a spare number five card?* Another learner answered," *I have a spare number five card"* and gave the card to the Sipho. By asking for two number "five cards" instead of one card with number 50 and the other card with number five, revealed Sipho's misconception of place value of numbers. Sue then explained to Sipho how to show 55 using the flard cards. Learners were no longer afraid of making mistakes, as they knew that it was acceptable to ask for help.

Sandy (teacher participant) explicitly stated that she used praise to motivate learners to participate as it helped her to understand how learners are learning. This sentiment was expressed in the following utterance: FG2/ Sandy *"Learners feel valued, even if their response is not the one that we want to hear. When his or her answer is wrong, I say, "Okay let's hear it from someone else". Until most of them have spoken in such a way that we can discuss all the ideas that they have given. So if I do not say yours is wrong, yours is right, then my learners feel free to participate"*.

Another strategy to engage learners was observed when Sue paired learners to work together on the activity as shown in Figure 4.6. Learners had to first estimate the number of sticks in a packet, write down the number on their whiteboards and then count the sticks to check the actual number. Sue walked around, observing the learners. She noticed that some learners were not working in pairs as they wrote different estimated answers on their whiteboards, instead of having a common number. One learner wrote 12 and the partner wrote 23 for the same group of counters she then asked the whole class to stop and explained as follows: "*When you work together, you have to agree on one estimated answer. You must help each other and then decide what you think the closest answer is*". Learners then continued to work together deciding on the more likely estimated number.

Figure 4.6: "Call a friend" strategy – Photo extracted from lesson observation

Again, Sue observed that two learners did not work together. As partners, they wrote different answers (One learner wrote 10, the other learner wrote 38). Sue asked each of the two learners to read out their numbers to see if they were able to identify the numbers, they wrote. She then asked them which number was more, which was less? She then asked the learner to show her ten fingers and asked "*Do you think the number of counters in the packet is the same as the number of fingers?*" After the feedback, the learners decided that 38 was a close guess. Sue walked around to ensure that everyone followed her instruction. Sue noted that some learners were confused, some looked around to see what others were doing, and some were erasing their answers after looking at other answers and rewriting numbers and some and did not know what to do next. Sue then said to the learners: "*Listen very carefully now. It is okay to have different answers. This is your guess. Do not change your guess. Now you must count your sticks and write down the answer."*

The strategy of working in small groups was also observed. Sue grouped learners into groups of four and gave each group of learners some counters to count out as seen in the three photos in Figure 4.7. Learners used different counting strategies to count out the sticks. Some counted in ones, some counted in twos, and some made groups of tens and kept aside the units. She called out the learners who made groups of tens to demonstrate their strategy to the others. Next, she asked learners to represent the number of counters using flard cards. She noticed that some learners needed help as she asked "*remember when we need help, what we do?"* and the learners said, "*call a friend".* Interestingly, it was evident that Sue created a classroom environment that tat fostered collaborative learning.

Figure 4.7: Grouping in tens – Photo extracted from lesson observation

Another strategy that was used to engage all learners in thinking was the “popsicle stick” strategy. The names of every learner are written on a popsicle stick or craft stick which is then placed in a container. This strategy required the teacher to first pose a question to the whole class, allow sufficient time for all learners to think and then select a name written on the popsicle stick randomly for a response. The name stick is placed back into the container and another name stick is selected each time a question is asked. Sam and Sue used this strategy but the way these strategies were implemented varied based on their own understanding. It seemed that Sue understood the purpose of the strategy as she posed the question to all the learners to engage the whoe class in thinking and then drew a name stick for a response. Sam on the other hand, showed misunderstanding of the purpose of the strategy as she first picked up a name stick and then asked the question to a single learner. Unlike Sue’s approach, which engaged all learners in thinking, Sam’s method, only engaged a select few whose names were picked.

Use of games, quizzes, and songs to engage learners

Elrie used games and quizzes to engage learners in learning. In one lesson, during the mental maths activity, Elrie played a game using a dice so that learners could do subtraction starting from 50. Elrie threw the dice to a learner. The learner who caught the dice read a number and had to subtract the number on the dice from 50, say the answer aloud and throw the dice to another learner who then had to subtract the number on the dice from that number that was last called. Most learners found subtraction difficult. However, it was most interesting to see how the children's thinking in calculating was made visible. Some children used their fingers, some looked at the number line displayed on the wall to help them to count backward, some used the counting chart, etc. One learner who had to calculate 42 – 5 = verbalised his counting aloud, "five minus two is three, so the answer 43. This activity required every learner to be attentive, as they had to remember the last number called out in order for them to continue. The teacher asked the child to use the counting chart displayed to check her answer, and immediately the child was able to self- correct her answer. Elrie also used quizzes whenever she realised that learners were getting disinterested in lessons.

Sam often used songs and dance to engage learners in participation Learners enjoyed counting rhythmically and in a singsong fashion. The study showed that the involvement of learners in practical activities, afforded teachers opportunities to observe learners thinking which was necessary to identify learners' difficulties and provide appropriate support.

4.4.3 Theme 3: Teachers have some awareness of skills and strategies to find out if learners have learned something

While teachers have the technical skills and strategies such as questioning and the use of white boards to find out if learners have learnt something, the study showed that teachers find it difficult to operationalise these techniques effectively in their mathematics teaching. This result in teachers obtaining information about learners' learning which is often not authentic.

Questioning as a formative assessment strategy

Teachers indicated that questioning is useful throughout the learning process and is asked at different stages of the lesson. As stated in the interviews questions were asked at the beginning of the lesson, during the lesson and at the end of the lesson as evident in the following utterances: FG1/ Bela/18*: In our morning recap, I ask questions and make a note. The most important is to see whether they remember the next day what you taught them the previous day";* FG2/ Sam/16 "*Questions asked during the lesson is to track understanding of teaching. Questioning is a daily routine exercise. Even if you forget, learners will remind you*"; and FG2/ Sue/25 "At *the end of the lesson, the teacher assess the learning by asking them for example questions on what they have learned, what they think about the lesson.*

The question types as well as the question techniques used by the teachers were analysed and presented under this subtheme. Question type refers to the mathematical thinking intended and question techniques refer to the strategies teachers put in place with regard to thinking and responding to questions. I drew upon the mathematics taxonomies proposed by Smith et al. (1996); Andrew et al. (2005) and Watson (2007) to categorise the questions used by the teachers in the study. The questions were categorised and analysed according to the following seven categories, namely; factual, procedural, structural, reasoning, reflective, derivational and yes/ no response questions as illustrated in Table 4.11 on the next page.

As mentioned earlier in this chapter, the mathematics lessons of four teachers were video recorded and transcribed. In total, there were twelve lessons, which comprised of three lessons per teacher. The transcriptions were then analysed using a coding system for the types of questions as seen in Table 4.3. The data collected from lesson observations were coded using a descriptive coding system (Miles & Huberman, 1994) and analysed using pie charts in excel to make comparisons and observe similarities and differences.

Table 4.11: Description of each category type (Adapted from by Smith et al., 1996; Andrew et al., 2005 and Watson 2007)

Categories	Explanation of each category
Procedural	The teacher emphasises or encourages the acquisition of skills, procedures, techniques or algorithms.
Factual	The teacher emphasises the recall and memorisation of factual information
Structural	The teacher emphasises or encourages the links or connections between different mathematical entities; concepts, properties etc.
Reasoning	The teacher emphasises or encourages learners' development and articulation of justification and argumentation.
Reflective	The teacher encourages learners to engage in critical thinking and self-corrective strategies.
Derivational	The teacher emphasises or encourages the process of developing new mathematical entities from existing knowledge
Yes/No response	The teacher emphasises the use of questions that require " Yes/ No"responses

The grouping of the questions into the different categories is significant as it helped me understand how the types of questions used by teachers shaped their formative assessment practices.

Table 4.12: Number of questions according to categories per teacher

	Factual	Procedural	Structural	Reasoning	Reflective	Derivative	Yes/ No	Total questions asked
Elrie	13	8	15	12	2	2	2	54
Bela	27	44	15	10	3	0	25	124
Sam	19	35	9	11	3	1	15	93
Sue	10	9	13	11	11	3	4	61
Total	69	96	52	44	19	6	46	332

The data in Table 4.12 is an analysis of the type of questions asked by the four teachers selected for the classroom observation. The type of questions asked by the four teachers varied as shown in Table 4.12. Bela asked the most number of questions in total (124 questions) followed by Sam with 93 questions, Sue with 61 questions and Elrie with 54 questions. Another finding is that the most common type of questions asked among all four teachers were procedural type (96 questions), followed by factual (69 questions), structural (52 questions); Yes/ No (46 questions); Reasoning (44 questions); reflective (19 questions) and derivative (6 questions). Teachers asked fewer reasoning, reflective and derivative questions. Interestingly, Bela and Sam asked the most number of questions which were mostly procedural, factual and yes / no response questions. Elrie and Sue, on the other hand, asked fewer questions which were mostly structural, reasoning and reflective type of questions. The findings suggest that teachers who asked fewer questions seemed to have asked cognitively stimulating questions

Figure 4.8 below is a graphical representation of the percentages of the types of questions used per teacher in the study.

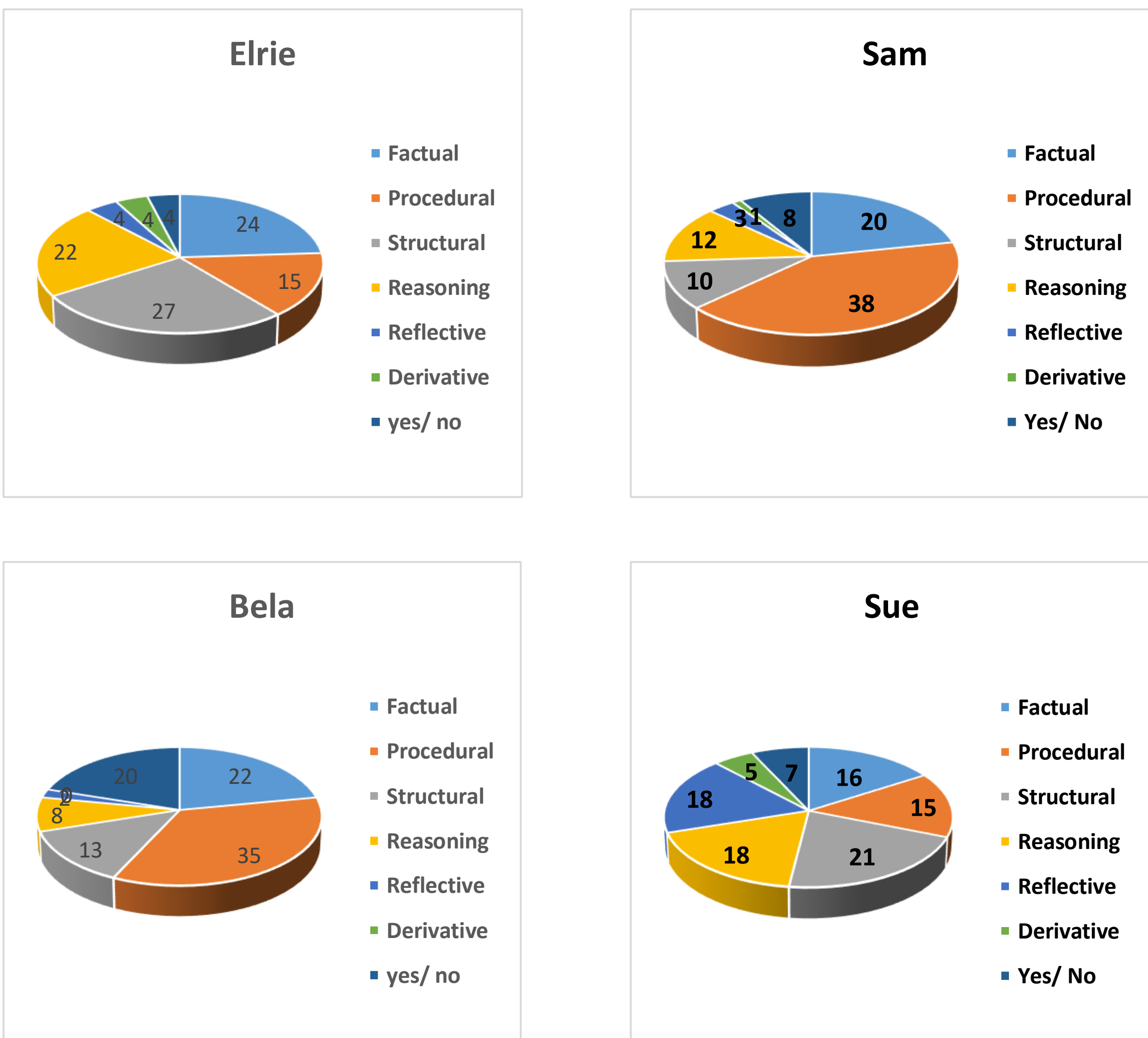


Figure 4.8. Percentage of the seven types of questions used by four teachers during the classroom observation

Figure 4.9 below represents the percentage of the total number of questions used by all four teachers.

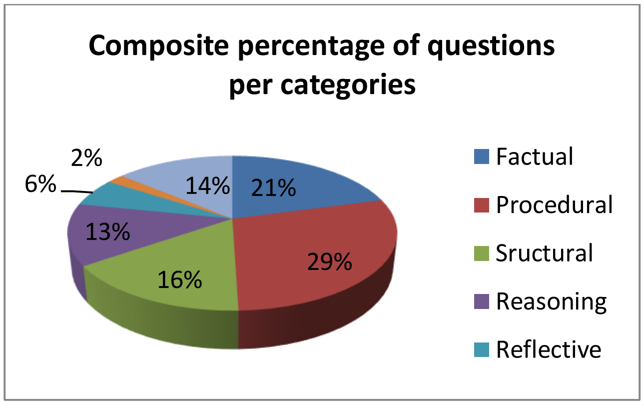


Figure 4.9: Composite percentage of questions as per question type

As evident in Table 4.11 (in the previous page) and in Figure 4.8 procedural questions were most frequently used, followed by factual questions. Interestingly, the factual and procedural questions constitute 50 percent of the total questions used among the four teachers. Reasoning, reflective and derivative questions were least used in mathematics teaching, yet are the most cognitively stimulating types of questions.

The use of procedural, factual and yes/ no response questions does not yield rich information about learners' thinking as evident in the following two episodes below:

CO1/ Bela/4: "*Do you remember what we learned yesterday? (No response from the learner. So the teacher answered)*

CO1/Bela/4: *"It was about greater and less than. Eh, do you remember*?"

CO/Bela/4: "*Can you remember this sign?" (Teachers shows less than and greater than sign)*

In this scenario, it is evident that the questions asked by Bela were factual, closed-ended questions required learners to recall memorised information with yes/ no response. For the purpose of formative assessment, yes/ no response type questions such as the above is purposeless as it does not provide any information on learners' thinking. Teachers need to ask questions that can delve deep into learners' thinking to be able to scaffold and support learning

Another episode that illustrates this point was observed in Sam's lesson on counting in fours. CO2/ Sam/7: "*Let us all say together 'you start on number four, then you go like this mmm (m stands for three jumps) to go to number eight. You say mmm, and then go to 12.* Sam then asked the class to skip count in fours using their own counting chart. She noticed that some learners struggled. She then asked the learners a series of the following questions: "*Where do you start? How many numbers did you skip? How did you do it*? *What did you do to get to the next number*? The learners were able to answer all four questions correctly. However, when learners were asked to count in fours from 16 to 40 on their own, they struggled. Most learners started from four again. In this scenario, it became evident that learners had the relevant behavioural knowledge but were unable to apply the knowledge in another context. All the questions were recall type questions that required memorisation of facts. It showed that learners remembered the rules but could not use it. This resulting outcome can be described as rote learning.

Contrary to procedural, factual and yes/ no response questions, reasoning and structural questions provided teachers with rich information to understand learners' thinking as evident in the following three vignettes.

Vignette 1: Elrie asked the learners to write their answers on the white board. She asked "*How many tens in 136*?" Some learners wrote 3 and some wrote 30. Elrie then asked the class to follow up questions such as "*Which one is correct? Are there three tens or are there 30 tens in 136? Are they the same*? *Is 1 ten the same as 10 tens?* The learners were actively involved in the discussion. She then asked the learners to show 3 tens and 10 tens using their dienes blocks.

Vignette 2: Sue asked the learners to use their flard cards to show 34 and 53. One learner raised her hand and asked the teacher for another card with number three. Sue then asked, "*Tell me why you need another 3?"* The learner replied "*Because it's for the three in 34 and the three in 53*" The teacher then asked "*What is the value of the three in 34*? The learner replied "*three tens*". Sue asked: *What is the value of three in 53*? The learner replied "*three units*". The teacher asked; "Do *you still need another three?"* The learner replied "*No*". Sue went on to ask, "*What is the value of four in 42*?" Learner replied "*four"*. The teacher then said, "*Are you sure, tell me why*." The learner then replied "*It's 4* *tens".* The teacher *asked,* "*How do you know?"* The learner replied: "*Because 42 is equal to 40 and two. Therefore, the four is a 40*".

Vignette 3: Sue asked the class to estimate the number of bottle caps in a box. Children wrote their estimated answers on the whiteboard. Sue then said, "*Show me how you would count all the bottle caps".* As learners counted, Sue walked around and observed that some learners counted in ones, some counted in twos, some made groups of tens, and some sorted them according to colours and then counted each group of colours. Sue then asked learners to explain how they counted. After a few learners explained, Sue then said to the class: "*Which do you think is the best method? Why do you say so?*" One learner replied: "*Teacher, it's grouping in tens, because then you don't forget where you stopped counting".*

The above three vignettes describe the formative assessment practices of Elrie and Sue. All three scenarios show evidence of learner-teacher interaction in which the teacher generates and acts on learners' responses. In each of the mentioned scenarios the distinctive, but complementary roles of both the teacher as well as the learners in the formative assessment process is evident. The central role of the teacher was to elicit data to inform the direction of learning throughout the ongoing learning process and the role of learners is to provide the data in the form of responses to be used in inform teacher's questions. In the case of Elrie's scenario, learners showed evidence of their misconception of three tens and 30 tens. Elrie then used prompts to stimulate the learner's thinking. Guided by the prompts, learners were able to reason that 3 tens are not the same as 30 tens. Together with the prompts, Elrie used Dienes blocks to reinforce learners' understanding that three tens are not the same as 30 tens. In the second scenario, it became evident that the learner lacked a conceptual understanding of place value. Sue asked questions that required reasoning to guide the learners understanding. In the third scenario, Sue asked the learners to use different methods to count and was able to elicit data on learners' knowledge of counting. Furthermore, most of the questions asked in the above three scenarios were open-ended questions which stimulated learners thinking.

It can, therefore, be concluded that reasoning type of questions as evident in the case of Elrie and Sue, generated rich data, which teachers could use to scaffold learners' knowledge. The types of questions constructed by Elrie and Sue were open-ended and provided rich data on how learners' think. Procedural, factual and yes/ no response questions as evident in Bela and Sam's examples often generate limited data that is insufficient for teachers to understand what learners know.

Questioning techniques and formative assessment

The analysis of the questioning techniques used by the teachers shed light on teachers' formative assessment practices. The amount of time afforded to learners in responding to questions emerged as a significant finding that contributed to teachers' formative assessment practices. The restricted time afforded to learners to answer questions, inhibited teacher's formative assessment practices as illustrated in the following scenarios:

CO2/Sam/8: "*Do you still remember yesterday what we learned about place value?"* Bela did not wait even for a second for a response but continued: *"For those who don't remember, its place value. Let us see now how much you remember*. *When we have 234, the two is a …. (Teacher points to the word hundred on the chalkboard) the three is …. (learners shout out ten together as the teacher points to the word ten) the four is … (learner shout out "units" together as the teacher points to the word unit*)".

In the above vignette, Sam intended to establish if learners remembered what they had learned the previous day. Sam asked a series of questions without pausing for learners to answer. After a question was asked, learners raised their hands to answer. Sam ignored the raised hands but went on to answer the questions herself. In other instances, Sam asked a question and pointed to the answer for learners to complete. In terms of formative assessment, the purpose of the questioning was to establish where the learners were in relation to the concepts that were taught the previous day with the purpose of moving the learners' work forward. However, this purpose could not be successfully achieved because learners were not afforded time to demonstrate their understanding.

Closely related to the issue of time was the problem of teachers' repeating the same question as described in the following scenario observed in Bela's lesson on the ordering of numbers. Bela told the learners that the following numbers (89, 4, 67, 45, and 78) lived in a house that was on fire. To escape from the fire, the numbers had to leave the house in an ascending order. She then said, "*Remember the baby number must go first.*

How will they go?" There was no response from the learner. She repeated the question: "*How will they go?*" After a long pause, one learner said, "*The baby number goes first*". The teacher did not acknowledge the learner's response but repeated the same question the third time "*But how will they go?* One learner replied: "*Teacher, number 4 goes first because it is the small number,* "Bela asked a different question now "*How you know that number 4 is the smallest number?*"

The same learner replied, "*When we go one, two, three, four, it's far from the 100 number".* Another learner replied, "*It's because all the other numbers are bigger than four".* Without acknowledging the answers, Bela repeated the question "*Okay, how you know that four is the smallest*?" The teacher then said "You *are getting noisy, be quiet. How do you know that number four is the smallest?"* The teacher then asked the question differently "*How do you know the other numbers are bigger?*" A learner replied: "*Teacher because we can see the big numbers have two digits but number four has one digit".* The teacher then explained to the learners that number four had only one digit, the others had tens. One child then replied," *But teacher we knew that*". Although the learners provided logical answers, their responses were not valued.

In the above scenario, it was evident that throughout the lesson, two questions were repeated several times "How will they go?" In addition, *"how do you know that number four is the smallest"?* The repetition of questions may be a possible reason why Bela and Sam asked so many more questions than the other teachers. Furthermore, the teacher did not acknowledge, value or affirm the learner's answers. A possible reason could be that the teacher was looking for a particular explanation. Teachers need to be flexible, considerate and open when addressing the different responses of learners. The repetition of questions as well as the disregard of the learners' responses may account for the learner's boredom and disinterest in learning. It was also observed that teachers often lead learners to the answers as evident in the following example: CO3/ Bela/9: *"What happens when you add a number? It means the number gets … (Learner answered bigger)*. In this example, it is evident that the learners are directed towards an expected response, which stifles the learners thinking and prevents them from expressing their own ideas.

In the examples cited above, it became evident that limited time to respond to questions, repetition of questions, teachers' providing the answers to questions and teachers' leading the learners to the answers constrained the teacher's effective use of formative assessment practices. However, while this practice was common among three teachers, one teacher was an exception, as she believed that learners required sufficient time to respond. This was evident in the following scenario as described below.

Elrie used a dice, which was a large block like a magic cube to play a game to teach counting on. Elrie threw the dice to a learner. The learner, who caught it, read the number aloud (four) then threw it to the next learner. The learner who caught the dice read the number on the dice aloud (three) and added it to number four (last number called out) and then said aloud "*four plus three is seven"*. The learner then threw the dice to the next learner as the teacher guided the direction so that all learners could get a chance to add. The next learner who caught the dice said: "*seven plus five is 12*". The game continued in this manner until most learners had to chance. Every learner in the class showed that they were attentive and became interested in the game. Learners could also expect the dice to be thrown to them at any time and therefore had to be alert. Learners were not pressurised to give the answers quickly as the teacher remarked, "You *don't have to rush, take your time and think before you answer."* The teacher observed how the learners got the answers. Some learner used their fingers to count on. Some held on to the dice and counted on by looking at the dots on the dice. As the number grew bigger e.g. two digit numbers (11 + 6) a learner said "*one and six is seven, my answer is 17*" Children had to listen to hear the last number called in order to add the number on the dice. Even where learners took time to answer, the others were patient and did not shout out the answers. Every learner gave the correct answers. Those who were unsure were prompted and supported to get to the correct answers.

The following day, Elrie played the dice game with subtraction. Starting from 50, it seemed that learners found subtraction more difficult and took longer to give answers. The first learner who caught the dice had to subtract the number four on the dice from 50 and said 46 aloud. The second learner who caught the dice had to subtract 3 from 46 and pass on the dice again. The third learner had to subtract one from 43 but struggled. The teacher then said: "*Let's give him some time*" The third learner then thought out aloud and said, "2 and 4, that's 42" Elrie then responded: "*That's nice"*. The following learner who caught the dice had to subtract 3 from 42 but struggled. The learner thought aloud "*three minus two is one, It's 41*". Elrie then said: "*Let me help you so that others can get their turn. Let us try again. Take out two from 42, what is it?"* The learner replied: "*40*" Elrie then said: "*Now take out one*" The learner then said "*39*" The game continued until the answer was zero.

During the post-observation discussion, Elrie stated that the classroom environment played a significant role in creating a culture of tolerance and acceptance. This was clearly observed in Elrie's' classroom as learners did not shout out the answers when an incorrect answer was given as they knew that with time and a little of probing, the learner will eventually get to the answer.

Use of whiteboards

During the focus group interviews as well as during the classroom observation it became evident that all teachers used mini whiteboards to find out what learners learned. In all classrooms, each learner had their own whiteboards, which they used to write their answers to the oral questions asked by the teacher. Once learners have written the answers, they lifted up the boards to show the other learners as well as the teacher the answers as illustrated in Figure 4.10. The teacher then scans the responses and gauge learners' understanding and misconceptions.

Teachers found the whiteboards to be beneficial as evident in the following utterances: FG1/ Elrie/34 "*Learners are free to write the answers even though it may be wrong as they can always erase and try again."* and FG2/ Sam: *I often ask learners to try on the whiteboard first. If they are successful then they write in their book.*

Figure 4.10: The use of mini- whiteboard – photo extracted during classroom observation

The effectiveness of the whiteboards was also observed in Sue's lesson, which involved counting, by grouping in twoss, fives and tens. Sue first asked learners to write down the estimated number of counters that was placed in a box. Learners wrote different numbers as an estimated answer. However, as learners looked around at their peer's whiteboard, they realised that their answers were different from their peers. Some learners, who noticed that their answers were different from the others, became unsure of their own answers and constantly erased their answers. The teacher observed children changing their answers after looking at their peers. She then replied "*Its Ok for you to have different answers. This is YOUR guess. It does not have to be the same as your friend's number".* The teacher then went on to explain, "*When we estimate we guess or we think how many there are before we count".* This scenario provided an appropriate opportunity for the teacher to explain estimation which was unplanned but occurred in the moment. Teachers also indicated that the use of the whiteboard benefited every learner, including learners who had previously been on the periphery of classroom activities, for instance, the shy child and those who had previously been disengaged:

> FG1/ Nelly/37: *Through the white board, even Thabo who is generally a very quiet and withdrawn child who never participates in discussion, becoming actively involved in learning through the whiteboards"*

There was particular evidence of improvement in the work and motivation of low performing learners:

> FG2/ Sam/42: *The low performing learners who seldom engage in class are becoming more motivated and interested in their work. Their concentration levels are also improving.*"

The use of whiteboard benefited learners of all abilities. It was easy for the teacher to identify struggling learners instantly to provide feedback. The mini whiteboards provided teachers with instant feedback on children's learning as the children wrote the answers to the questions on the boards instead of verbally presenting their answers. Teacher asks learners who do not raise hands. The learners who raised their hands were disregarded. Learners were curious to know whether their answers were right so they looked at their peers work to see if their answers were the same as theirs. In some instances, learners told their peers that their answers were wrong. In one lesson in Bela's class, a learner (Mpho) looked at the answer of his peer and then said: "*Teacher, Zanelli needs some help*". This shows that the whiteboard also provided opportunities for peer assessment. It became evident that learners want an affirmation of their answers from the teachers in order for them to progress in their learning.

However, there were also some episodes observed in the study which showed the detrimental effects of white boards which hindered teacher' formative assessment practices. Sam looked for incorrect answers on the white board and asked learners with incorrect answers to stand in front of the classroom so that others could see the answers. Instead of providing feedback to tsupport the learner, Sam called another learner to the chalkboard to write the correct answer.

A similar incident was noted in Bela's classroom where she asked the four children who wrote incorrect answers to stand up and to show their anwers to the others. These learners hesitantly stood up, as they were embarrassed. Interestingly each learner had different answers showing different ways of thinking. Instead of providing feedback to each learner, Bela called another learner to explain the correct answer on the board. She then said to the 4 learners "*Do you all understand now*?" There were no checks to see if the 4 learners had grasped the concept as the learner, who was called to front simply wrote the answer without explaining the process. Each learner had different answers which were incorrect and required different explanation tat was appropriate to their error/ misconception, yet Bela assumed that all four learners would have understood after one explanation. It can therefore be concluded that the data gathered through the use of the white boards were ineffectively used or the formative purpose, as the support/ feedback was not based on the errors/ misconceptions of individual learners. In another episode, Sue asked the learners to write on the whiteboard how many tens in 43. Most learners wrote 4, but one learner wrote 40 on the whiteboard. Sue repeated the instruction to the learner "*Listen carefully. I said how many tens in 40*" and walked away without providing supportive feedback to guide the learners' learning.

The use of Assessment for learning strategies

The teachers in the study stated that the strategies they acquired during the AfL workshop were very effective in finding out what learners have learned. One teacher, Sue stated that the formal assessment such as tests and assessment tasks has little value in providing teachers with information on what learners have learned. This was explicitly stated in the following utterances by both Sue and Sam: FG2/ Sue: "*It's because you assess only what you taught, so learners regurgitate the way you have been teaching them*" and FG1/ Sam: *The exit tickets help me to see if I have to repeat the lesson. Sometimes when learners complete classwork, they copy. But when they write the exit ticket, they write what they have learned, not what you have taught them".*

Another AFL strategy that was practiced by two teachers in the study was the "traffic light' strategy to establish learners understanding. These teachers also had the necessary resources required for the strategy. Each learner had three blocks (red, amber and green) to indicate the level of, their understanding of the concept that was taught. Red was used to indicate poor understanding, amber was for partial understanding and green was for good understanding. The purpose of the traffic lights example was to give learners the opportunity to monitor and reflect on their own learning. This improves their motivation and self- esteem and creates the context for them to take responsibility for their learning and develop a sense of belonging as motivation to learn independently.

During the focus group interviews, both Sam and Sue stated that the traffic light strategy was very useful as it allowed learners to express their understanding without any fear as expressed in the following utterance: FG2/ Sue: "*Learners are willing to describe their knowledge as 'red' rather than 'I don't know*" and FG1/ Sam: "*Learners will even raise their red block to tell you where they are struggling. Some learners use their red block to ask for help*". However, Sue's utterance was not practiced in her classroom as Sue seldom used the data for the formative purpose. In one instance, a learner raised a yellow block, as he did not understand the place value of the digits in 134. The teacher asked the class if there was anyone that could help the learner. A learner came to the front and gave the answer indicating the place value as follows: In 134, the 1 is hundred, the 3 is tens and 4 is units. Another learner gave a slightly different answer and gave the place value of each digit e.g. 1 = one hundred, 3 = 30 and 4 = 4. The child watched but was not engaged in the learning. The teacher then repeated what the two learners have done, and repeated the way she taught the class using the same method. Then asked the learner, *"Can you tell me now what the place is"* .Once again, the learner still could not answer.

In another instance in Sue's lesson, a child raised a red block, two children raised yellow blocks. She then looked at the child with the red block and said, "Ok you did not understand because you were not here yesterday." However, she did not help the child, went on with the next activity. The traffic light strategy was used by teachers to encourage learners to take shared responsibility for their learning. When learners are able to assess the level of their learning, it shows that they are able to take ownership of their own learning.

Practical Demonstration

The teachers mentioned the importance of practical demonstrations in finding out what learners have learned. Teachers explained that observing learners engaged in practical work, allowed them to identify the error and misconceptions of learners.

This was explicitly expressed in the following utterance:

FG2/ Sue/42: *What works for me is to see why children are getting it wrong. Children must understand why they got it wrong. The other day I was teaching numbers using flard cards. Each learner had his or her own set. I asked them to show me the number two hundred and fifty-seven. I saw some of them pick up 2, 5 and 7. Then I said to them 2+ 5+7, is it going to give you 257? Think why not. Try again"*

In one of Elrie's lessons, learners read the instructions together. This was a practical activity. Learners had to add two digit numbers by cutting out the tens and units, grouping the tens together and then the units together. Each learner was given a sheet with cutouts of base ten hundred and units. Learners had to cut out the number of rods, etc. to match the numbers. While learners were busy with the practical activity, the teacher walked around and observed learners working. Common errors were identified.

During the post-observation discussion, Elrie stated that she often assesses learner's understanding by looking at the responses of the brighter learners as she remarked, *"If the brighter learners are confused about place value, then I start to worry. If they struggle then what about the others? I then think of alternate ways to check for understanding, most through oral questions"*

Another teacher used demonstration on the chalkboard as a way of finding out what learners know. Sue had sign cuts of greater than and less than signs pasted on the board. Learners took turns to come to the front of the board. Each learner had to select two cards with numbers from a box the learners had to place the smaller number on the closed side and the bigger number on the open side of the sign. The teacher asked a learner to select the number that is equal to 42. The learner stood up and could not find the equal number. The teacher then said: "It means that she doesn't understand the word "equal". *Go and sit down. Who can show her*?" Another learner came to the front and selected another 42. Teacher asks, *"are these numbers equal?*' In addition, the class replied: *"Yes".* The teacher then said to the learner who could not find the equal number: *"now you understand, eh?'.* In this instance, the teacher did not afford the child the opportunity to demonstrate her understanding. Furthermore, the teacher did not explain what equal means as a result no authentic learning took place.

It became evident that data discussed under this theme indicates that while teachers use different strategies to find out what learners have learned, they do not think deeply about what they want to find out from using the strategies. For instance, when they use questioning as a strategy, they do not ask the right questions that would provide information on their level of understanding based on what they were taught. At most times, the questions are unrelated and irrelevant to the outcomes of the lesson, and therefore does not provide the teacher with appropriate information that can be used to inform the teachers' instructional decisions. Similarly, during the observation of the practical demonstrations, the observation is not focused on the knowledge and skills relevant to the outcomes.

4.4.4 Theme 4: Teacher's limitation and usability of formative assessment in improving learning

I present theme four under the following sub-themes, namely:

- Teacher's idiosyncratic understanding of formative assessment
- Teachers' tokenistic ways in implementing AfL techniques
- Teachers' variation in the quality and format of feedback

Teachers' idiosyncratic conceptions of formative assessment

The term "conception" is borrowed from Thompson (1992) to refer to teachers' beliefs, meanings, concepts, propositions, rules, mental images and preferences related to formative assessment. During the focus group interviews, teachers were asked to share their conceptions of formative assessment.

The following utterances provide valuable insight into what formative assessment meant to teachers, its purpose and how it was applied in practice:

FG2/Sue/13: To me, it is about gathering information to improve children's' learning. It gives me information about whether they have learned or not".

FG2/Elrie/15: "I actually like this form of assessment as it makes the teacher go back and forth in her teaching until the learner achieves the outcome".

FG2/ Kayla/16: Formative assessments are useful given the request that we get from *higher up to identify learners at risk and to help them in their learning."*

FG1/ Bela/18: It is something we do all the time to know where the learning gaps are.

FG2/ Nelly/18: "When we pick up where children need help in their discussions or practical work, then we help and support them"

Elrie alluded to the seamless integration of formative assessment. She views formative assessment as embedded in instruction. In this regard, Elrie stated "*My whole life I used formative assessment. That is for the past 30 years. But it did not have a name then, but it was there… done minute by minute, day by day'*.

Some teachers reverted to talk about the challenges of summative assessment in relation to formative assessment while providing the following reasons:

F1/Bela/28:" Children make silly mistakes in their formal assessment because they are nervous. Yet when we ask children orally or to show you practically we can pick up where they need help and support them the same time"

F2/ Sue/32: "We only start formal assessment in about three weeks' time and I can say, I already know my children. I can write down the names of the learners who are going to fail at the end of the year. So these formal recording is for the district. Why can't they allow us to teach?

FG1/Anna/29: "The formal assessment results that the department gets, is distorted because it is not really a true reflection of what the child can do or what happens in class"

FG2/ Elrie/32: Because you are working with that child, from half-past seven until half-past one, you know exactly what that child's capability in mathematics or in any subject is. This happens through your daily observation, questioning etc. You are assessing all the time. You do not need formal assessment"

The responses suggest that teachers' conceptualisation of formative assessment was vague and fragmented. None of the teachers mentioned that formative assessment is a process involving different components. Most focused on gathering evidence, but none mentioned interpreting the evidence for instruction.

Tensions in the enactment of formative assessment

The tension between the accountability of summative assessment and formative assessment emerged as a key finding under this theme. It was the view of many teachers that formative assessment is being discounted because of the high status is given to summative assessment for the purpose of accountability. The following response from Kayla succinctly articulated the problem of accountability:

> *"Unfortunately because the department has to answer to someone else, they have pressure to supply favourable figures and numbers on learner's performance. So further down the line, the production has pushed up, the quality of the product is of a low standard. If we as teachers had to take an oath like the medical professional, all of us would be guilty and our practice number would have been taken away. It because we are not doing what we said we would do as an oath. That is the nature of the beast, we need to produce. The question is "Do we produce enough, do we produce the right quality of the right quantity? The answer is "quantity YES, Quality, NO*"

It was also evident in the dyadic interview with the subject advisors, that teachers are focused on results oriented learning outcomes due to departmental pressures to produce high scores in the assessment. The pressures to produce high scores in summative assessment resulted in teachers' teaching the exact questions that they will be assessed on in the formal assessment as stated by Anna: "*Before the assessment, we work through it in class and the children do them as homework. So two, three four days down the line, with a little bit of tweaking it becomes the formal assessment. By the time the children do the formal assessment, they know what to do"*. Sam alluded to the consequences imposed on teachers for low scores: "*Schools that are underperforming become target schools for school support visits in the following term*". Teacher has resorted to using procedural ways to get learners to remember the steps.

Bela stated: "*We drill and drill until learners can remember what they need to know in their formal assessments. So much of time goes into drilling, leaving teachers with less time to teach new concepts*" Procedural ways of teaching results in surface learning.

Both Kayla and Bela explained the problems arising from teaching the content in the assessment as follows: "*We focus more on the assessment target at the end of the term to get the child on that level. Then we end up assessing only what the child was taught, not what the child knows"* and Bela: "*Even the questions that are asked in the ANAs, learners show that they do not understand. It is because we teach only a method that we know is going to be tested".* This point was reiterated by one subject advisor as she stated:" *Teachers have become so results driven that they teach only what's in the formal assessments so that they can high scores".*

> FG2/Anna: *Before the assessment, we work through it in class and the children do them as homework. So two, three four days down the line, with a little bit of tweaking it becomes the formal assessment. By the time the children do the formal assessment, they got some idea.*

Another concern advanced was the district requirements for written evidence in learners' books to show that the work has been covered. This demand constrained teachers formative assessment practices. Formative assessment requires the teacher to make in the moment decisions to adapt and adjust their instructions according to the needs of the child. Dona also expressed her frustration at the following a prescribed curriculum and having to account for everything that she does in her classroom. This sentiment was expressed as follows: "*If I suddenly have an idea and decide to tell the children to practice it in their workbook, I can't because it's not on black and white. Then my HOD will come back and say 'but where is it in your planning? That is what I am talking about. I am doing it. Everybody wants that evidence, proof. Why do you need that proof? Why? So in that case, we don't want to even do what's not in our planning, even though if we know it can improve learning".* Dona's formative assessment practices are constrained by the departmental rules and regulations.

The issue of time was also raised as a barrier to formative assessment as expressed by Elrie: "*Formative assessment should inform our formal assessment but because we just don't have the time to do that at the moment"*. Both Sue and Elrie expressed similar frustrations at having to rush through their teaching in order to keep pace with the scheduled formal assessments. *FG1/Sue: Most of the time we are assessing them on* *work they have not done. We rush through our teaching, to get to the assessments",* and *FG2/Elrie: "When the number of assessment tasks was determined for every Grade it became a real problem. It meant rushing through my teaching to get through the required tasks so that I can have my recording up to date. So there is no time for formative assessment"*. Teachers viewed the new approaches to pedagogy and assessment as time-consuming. Involving learners in self- and peer assessment as more discursive and interactive lessons and improved questioning led to a slower pace of curriculum 'delivery' and concerns that the curriculum may not be 'covered'. Teachers alluded to time as a constraint to the formative assessment practices: "*But tell me, where is there time to do all this? With the GPLMS, every day it is a new concept. If there's no written work, you are in trouble"*

There was sufficient evidence that showed explains the limited use of formative assessment that was caused by the overemphasis of summative assessment for accountability purposes.

Tokenistic adoption of AfL strategies

Teachers in the study stated that their teaching has changed since they attended the AfL workshops as stated by Sue: "*I teach differently now. It's about using the strategies"* and Sam "*I write down on the board every day what they are going to learn".* It became evident in the lessons observed that a large portion of teaching time was spent explaining the learning intentions as described in the following vignette observed in Sam's lesson:
CO/ Sam/1: "*We are going to learn to put the numbers in the right place or position. We are also going to know the importance of the three-digit numbers in each plac*e." She then said to the class "*Now who can tell me the success criteria for these learning intentions?* She then said ´*Our success criteria is what we are looking for*. *You will put the numbers in the right places. You will break numbers into hundreds, tens and units.*" Sam wrote this on the chalkboard and asked the learners to read aloud many times the learning intentions and success criteria until they could memorise it. I observed that the activity of making the learning outcome explicit to learners took nothing less than 14 minutes. In one class, most of the time was spent on drilling the learning intentions and success criteria until learners could memorise it. What exacerbated the problem was that teachers used the

terminologies and language which they encountered during their own training to teach the learners. Apart from the complexity of the language, english was a second language for most learners in the class. Teachers also mentioned that these strategies were new to them and they found it a challenge to integrate it in their existing lesson plans as stated by one Sue "*We were never shown how to integrate it in our lesson plans. But we were told to do this now*" This sentiment suggests a perceived lack of support from the department and school management team.

Teachers also alluded to the limited time as a constraint in mathematics teaching. Teachers view the strategies as an "add-on" to the lessons, rather than as an integrated process as stated by Sue "*The strategies are good, but now we must teach our children the learning intentions. Where is the time to do this?"* This comment suggests teacher' misunderstanding of the use of the techniques as teachers view it as something to be taught to learners. As one participant stated '*the communities of practice meetings help us to unpack the learning outcomes, but we can't always find time to meet"*

Teachers' variation in the quality and format of feedback

This study showed substantial coherence among teachers' beliefs and consistent associations between their practices. The study revealed that teachers used both effective as well as ineffective types of feedback in mediating learning. When the feedback failed to produce an improvement in learning, it was deemed as ineffective.

Teachers who focused on getting the correct answers than emphasising the understanding of mathematics concepts were inclined to use procedural methods of teaching. The case in point is evident in the following vignette as illustrated in Figure 4.11 below. Bela asked the learners to write down how many tens and units in 34 under the tens and unit columns. Bela then said to the whole class: "*Now I wonder which one is correct. Some learners wrote 30 in the tens column and some wrote 3. Are you telling me there are 30 tens in 30?*" as seen in Figure 4.11 on the next page.

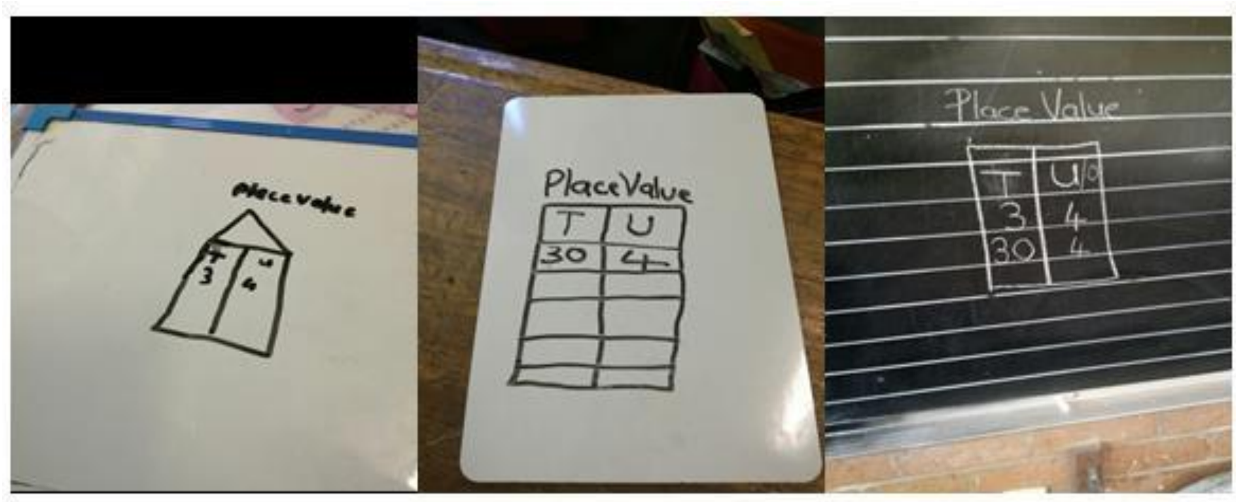


Figure 4.11: Teaching place value – photo extracted from lesson observation

The learners who wrote 30 in the tens column demonstrated a lack of understanding of place value and total value. Place value is the position of the digit, i.e. the place value of three in 34 is three tens and the total value is the value of the digits according to its position, i.e. the three in the tens place has a total value of 30. Another learner replied, "*teacher 34 has three tens and four units*". Bela then said "*Very good. Now let's do another example*". Here again, the same learners had the answers wrong. Bela failed to provide feedback to address the learners misunderstanding but asked another learner to give the correct answer. In this example, there was no feedback given to the learner to improve her understanding. Hence, it is most likely that the learner will continue making the same error.

The feedback that was directed to the whole class was also viewed as being ineffective as described in the following episode. The teacher, Sam asked the learners to write down how many tens and units in the number 84. One learner, Mpho drew sticks and made groups of tens. Sam then said to the whole class "*Mpho drew 84 sticks, when you do it this way, you can make mistakes. You can miss counting a stick or you may count the stick twice"* In this example, Sam observed Mpho's strategy of grouping by drawing in ones as being inefficient. Instead of asking Mpho questions to guide his thinking towards using more efficient strategies, Sam explained his problem of grouping to the whole class.

Furthermore, the feedback focused on getting the right answer using the procedural method, which was evident when Sam explained to the class "*So in Grade 3, you shouldn't draw. Look at the first digit and that will tell you how many tens".*

A similar practice was observed in Bela's' lesson when she asked learners to match two-digit numbers with flard cards. A learner (Sara) picked up the number 42 card but could not identify the matching flard cards to show expanded notation equal to 42. Bela then said to the whole class "*Sara cannot find the matching set. It means that she does not understand the words equal. Who can show Sara the correct card?*" Bela called another learner to select the card with the expanded notation of 40 and 2. In this example, Sara could not find the match of the two digit cards and was not helped by the teacher. This was another missed formative assessment opportunity because no attempt was made to support Sara to improve her understanding.

In another lesson, Bela asked learners to subtract a two-digit number from a three-digit number using the vertical method. The following example was given to learners to calculate:

H	T	U
2	3	2
	1	6

While the learners were calculating, Bela walked around and observed errors made by learners. She then said to the whole class:

> *"I see some added two and six. You cannot add. This is subtraction. I also see some subtracted two from six. You can't change the numbers around. So what can you do? Do you want me to help you? Who thinks they have it right? Do you want me to show you? If I don't show you, you will not get it right*." One learner replied, "*Teacher let us try first". The teacher then said, "Ok, call me if you need me to help you".*

After approximately two minutes, Bela said, *"I see all the steam coming off your ears, you are all thinking hard, but let me show you".* Instead of providing feedback to learners on how to do the calculations, Bela first pointed out these as errors to the whole class and then went on to explain the answers to the learners using procedures as follows:

> "*Now the first thing that I told you is that it is minus (232-16). Do you remember? In addition, you did not have a number there [before 16] Did that confuse you? You can put a zero there, but you not allowed putting a zero after a number. Because if you put a zero after the 6 in 16 it will be 160. The zero before the number tells you there is nothing. If the block is empty, you will not know what to do. Am I right? Then you were stuck again. Because it is two minus six. It is because the six is bigger. Can I swop the two numbers around? No."*

This episode represents a missed opportunity for formative assessment. If Bela provided feedback that addressed the learner's errors and if the feedback resulted in improved learning then we can conclude that the feedback was used effectively for the formative purpose. Rather than providing a logical explanation, Bela used procedures to show learners how to get to the answers. Hence, the learners did not understand the concept. This was evident in their calculation to another similar example.

Another example of ineffective feedback was evident in Sue's lesson when she asked learners for two numbers less than 50. One learner said 48. Sue then repeated four times "I said two numbers less than 50". The learner repeated "48" again. It seems that the learner understood the question as 2 less than 50 and therefore gave the answer as 48. It is therefore important for learners to explain how they got to an answer. This would enable the teacher to provide appropriate feedback based on what the learner was thinking when they gave the answer.

The mismatch between teachers' feedback and the learning goal was another problem that was observed. In one lesson, learners had to add two 3-digit numbers. Learners could choose the vertical addition or the expanded notation strategy. Each learner had different sets of numbers as learners had to select a digit out of three different containers and write their three digit numbers. Sue noticed a learner struggling to calculate using the expanded notation method.

The learner was able to get all the steps right except for the last step as seen in Figure 4.12 on the next page.

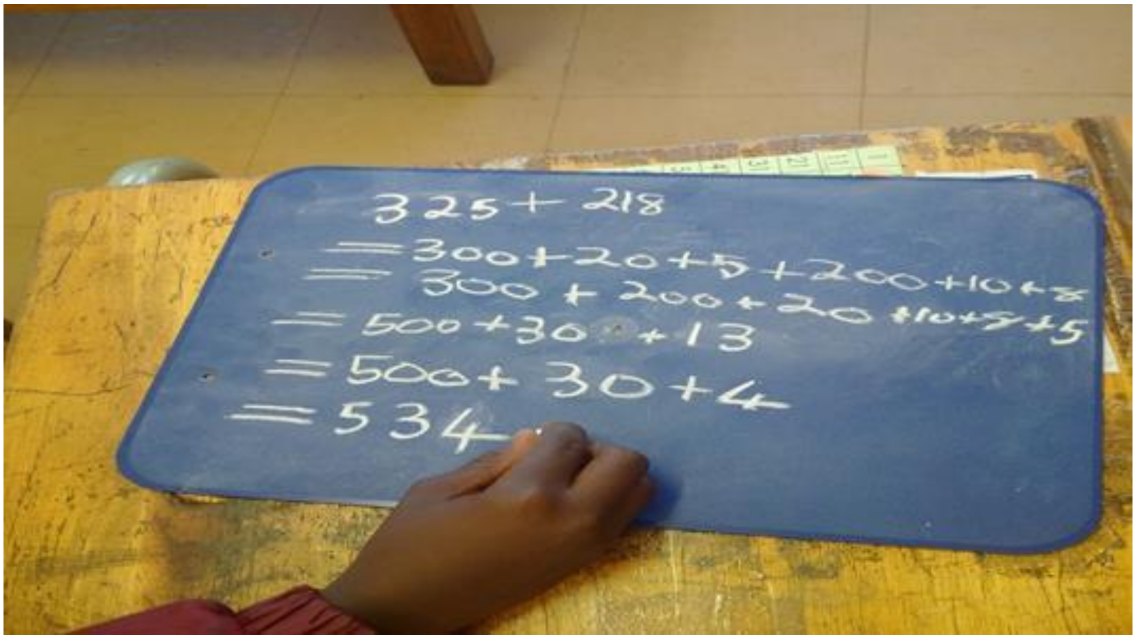


Figure 4.12: Error in regrouping – photo extracted from lesson observation

Looking closely at the learners work in Figure 4.12, it is evident that the learner went wrong in the fourth step as the learner has a problem with regrouping. Instead of regrouping 13 into 10 and 3, the learner added 1 and 3 in 13 to get 4. Instead of identifying and addressing this error using the strategy of expanded notation, the teacher showed the learner how to use the vertical method and carry over to get to the answer. This shows a clear mismatch because the learning goal was to get the answer using the expanded notation. Changing the method to vertical addition to get the right answer to a problem of expanded notation shows the mismatch of the feedback to the learning outcomes.

The study showed that teachers seldom use feedback to confirm, whether the answers are right or wrong, which then creates uncertainty in learners. This was evident when Sue asked the learners if the value of 5 is greater in 15 or 51. A learner replied 51. Instead of confirming whether the answer was right or wrong, Sue went on to ask to follow up questions "*Why 51*?" and the learner replied "*It's bigger than 15*". The teacher then asked, "*How do you know 51 is bigger than 15*?" There was no answer. The teacher then asked the class "*Is there anyone who can help with the answer?"* The same learner then changed her mind and said 15 is greater. Instead of first confirming that the answer was correct, Sue went on to ask a number of questions, which confused the learner. For feedback to be effective, it should be aimed at closing the gap between the learners' current level of understanding and the desired learning goal.

The above examples were used to illustrate the point that when feedback focuses on getting the correct answers, the opportunities to learn diminishes. On the contrary, when feedback focuses on the process of learning (as in the examples that follow), then opportunities for learning is enhanced. Feedback was most effective when it was directed to the process of learning as described in the following vignette. Sue asked learners to work in pairs. She asked learners to first estimate the number of counting sticks that was in a packet, then to count out the actual number, and lastly to find out the difference between the estimated number and the actual number counted. Sue observed that instead of working in pairs, learners worked individually. Some learners shared the counters so that each had their own set of counters to work individually. Sue then said to the class "*I see that most of you have different answers on your whiteboard. This means that you are not working together. When you estimate, its okay for you to have different answers because it is your guess. However, remember, you need one answer. You must decide with your partner which one of the two guesses is the answer".* Sue realised that some learners did not understand the meaning of "estimate" and may have been confused with the multiple instructions that were given to learners. She then adapted her instructions by asking learners to do one step at a time; first to estimate the counters and to decide with their partners what was the nearest estimated answer. Next, she asked learners to do the actual counting and waited until most learners had done this step. Finally, she asked learners to find the difference. In this episode, it was clear that the feedback had a formative function as Sue identified the problem, adapted her instruction accordingly which resulted in improved learning outcomes.

In another lesson, Sue drew three columns on the board, the hundred column, the ten columns, and the unit column. Sue said, "*I have 3 units, how many tens do I need to make 43*". Using the lollipop strategy, Sue called out a name and asked the learners to write the answer on the chalkboard. A learner wrote four. Sue asked, "What does the 4 in 43 mean?" Another learner replied 40. Sue gave different examples. If I have nine tens and I need 96, how many do I need? The learners did not answer. When Sue realised that the learners still did not grasp the concept in spite of using several examples, she then decided on using a drawing strategy to make it visual to learners. She drew 43 sticks on the board using tally counts. Therefore, she drew eight groups of fives using tally counts as the children counted along. Then drew three ones. She then regrouped the two groups of fives into tens. The learners counted in tens. (10, 20, 30, 40) She then asked' how many tens? How many units". Sue adapted her instruction by using visual representation, which then improved the learner's understanding.

The following examples are used to illustrate how teachers' feedback resulted in learners' self-regulation, which contributed to, improved learning. In one episode, Sue asked five learners to count out counters from a box, which was given to each learner. Sue observed that learners used different strategies. One learner counted in ones, three learners counted in twos, and one learner made groups of fives. Sue observed that Thabo was counting in ones and then said to Thabo "*You need to count faster now; the others are almost done with counting."* Without telling Thabo how to count faster, Thabo started counting in twos. It became evident in this episode that Thabo revised his strategy through the teacher's guidance without the teacher telling him what to do.

The teacher then had a discussion with the class about how each learner counted. She asked the following questions: "*How did Thabo count? How did Anna count? Who was quicker*?' The teacher then put the learners into groups of fives and asked learners to find the quickest way to count out the counters out of a box. She also provided polystyrene cups to each group and said, "*You can use the cups to do grouping to make your counting easier* "Some learners counted in twos and some in fives. The group that finished first had 12 cups and five left over. They then counted in 10s, said that there were 120, and counted on the five ones to get 125. The example cited above shows that the formative feedback given to learners in the preceding activity, helped learners to conceptualise the idea that counting by grouping is a more efficient strategy.

The second example was cited from Elrie's lesson. During the mental math activity, Elrie asked the class "*What is 42 - 3*". A learner answered 41. Elrie then said, "*Let's try again. Here we have 42 (Teacher wrote on the board). Can we take out 3 from 2*"? The learner replied “No”. Elrie asked: “*What can we take out from 2?”* The learner replied: “*1 and 2”* Elrie said, “*Okay, let’s take out 2, what are we left with*?” The learner replied “40”. Elrie then said “*But we need to take out 3, you remember. We took out 2, now take out…? The learner said 1 more.* The learner then said “39”. Elrie guided the learner by asking questions until the learner got to the answer which was a very effective formative assessment episode. However, there was no conclusive evidence that the learner had conceptualised the concept, as the learner was not given the chance to demonstrate her understanding on her own.

The third example was observed in Sue’s lesson. Sue asked the learners to pack out the flard cards to show the following 2 digit numbers: **19, 34, 54, and 53.** Each learner had their own flard cards, which comprised of sets of number cards from 0 to 9, from 10 to 90 and from 100 to 900. A learner asked the teacher for another 4. The teacher asked her: “*But why do you need another 4?”* The learner explained for numbers 34 and 54. The teacher then said, “*That’s very good. Do we all need two fours?* ” Another learner replied, “*Yes. And I also need two 3s for 34 and 53*’. The teacher then asked the learner to pack out 34, and the learner placed 3 and 4 for 34. The teacher asked, “*What does 3 and 4 give you*?” The learner replied 34. The teacher asked, “*What is 3 plus 4?*” The learner replied “7”. The teacher then said, *“Good. Therefore, three and 4 gives you 7, not 34. Then what number do you need to show 34? What is 34 equal to? Use two cards and show me what makes 34?*” The learner then took out 30 and 4. The same learner then showed 53 as 50 and 3. The teacher then asked “*Do you still need another 3*?” and the learner replied “No”. Unlike the previous example, the learner developed conceptual understanding by showing 54 correctly.

4.4.5. Theme 5: Teachers have limited conceptual knowledge of mathematics and how to communicate them clearly and coherently in instruction

In this theme, I describe the teachers’ limited conceptual understanding of mathematics knowledge. During the focus group interview, a question was posed to find out what teachers know about how children learn mathematics and how their conceptual and procedural understanding develops. Teachers were more confident talking about their procedural skills than conceptual knowledge. Even the learners' books showed that most of the examples and activities that learners had to complete focused on procedural knowledge.

This theme will be discussed under the following three categories: Teachers' limited conceptual knowledge of mathematics; teachers' awareness of adapting instructional strategies to learners' needs and teachers' haphazard and non-coherent use of analogical reasoning in explaining concepts to learners.

Teachers' limited conceptual knowledge of mathematics

It became evident in the study that teachers relied extensively on procedural ways of teaching in relation to conceptual understanding. During the focus group interviews, teachers stated that rote learning, memorisation and the applying rules played a significant role in mathematics learning as expressed in the following utterances: (FG2/ Sue/16) "*With mathematics, there are steps that children need to follow to get to the answer. It's not like a story where you can start from any point of the story, yet reach the end". Mathematics, is about remembering and following the sequence of steps*";

Participant (FG1/ Dona/14) mentioned that: "*Once learners remember the rules and can use the rules to calculate, then you know that learning has taken place*"; (FG1/ Sam/22) "*When we started teaching, we used to drill and drill until the learner gets it. This curriculum does not allow time for drilling. It is like 'Are you coming or not?"* and (FG2/ Elrie/21)*:* "*Mathematics requires remembering and there is no better way to remember than repetition and drilling".* The degree to which procedural ways of teaching varied among teachers. However, all teachers relied on procedural approaches during mental math and counting activities which were done at the beginning of the lessons. These activities emphasised drilling, repetition and rote learning. In some classrooms, a greater proportion of time was spent on practice and repetition, which reduced the time for cognitively stimulating instructional conversations such as the formulation of explanations, problem-solving or application of concepts.

Interestingly, those teachers who relied exclusively on procedural methods believed that learning was about getting the right answers from learners as opposed to conceptual understanding and application. This view was succinctly expressed in the following utterance: FG2/Dona/32: "*If you do not get the right answer it's like you have not understood the concept. So teaching learners rules to anything is very important".* Contrary to Dona's view, Kayla argued that getting the correct answer is not as important as the method used to get to the answer. Some questions assess the methods, rather than the correct answer as expressed by Kayla: (FG1/Kayla/18) "*When we teach expanded notation, we find that the steps are wrong, but the answer is correct. The learner may get the answer correct by carrying and borrowing, but that is not what is required when you want to assess learner's knowledge in using expanded notation to calculate.*" Hence, Kayla motivated that teachers need to expose learners to a variety of strategies to solve problems. Kayla also cited one example of a question from the ANA assessments, which was marked wrong because learners did not use the prescribed method that was asked in the question. Instead of using expanded notation, most learners' got the answer to the calculation correct by using the e vertical method. It seemed that teachers were aggrieved because of their lack of understanding that the question was aimed at assessing learner's understanding and application of expanded notation to calculate, rather than getting the correct answer.

The findings presented in the previous sections also showed that teachers have difficulties in communicating the knowledge (content) to learners in a coherent manner. This was evident in the following episode, when the teacher, Elrie tried to provide an explanation to a learner who struggled to calculate 132 – 16. Elrie provided the following explanation: "*Write number 132 under hundreds tens and units columns. Then 16 is a two digit number. Write it under tens and units column. There is no number under the one in 132 when the sum is written vertically. Did that confuse you? You can put a zero there, but you not allowed to put a zero after a number. If you put a zero after the 6 in 16, it will be 160. The zero before the number tells you there is nothing. If the block is empty you will not know what to do, so just fill that space with a zero".*

Elrie was confident in her mathematics knowledge that adding a zero after a number changed the value of the number, but could not provide a logical mathematical reasoning of why it was true. In the same lesson, Elrie continued as follows: "*Then you were stuck again. Because it is two minus minus. It is because the six is bigger. Can I swop the two numbers around?* (There was no response from learners).

Elrie gave an example to illustrate how the sums change when the numbers are swopped around (e.g. 7-3 and 3 -7). She then went on to explain, "*Because this unit [2 in 132] is not big enough, you need to borrow 1. But where do I borrow from?"* The learner replied "*from 3*" [*the 3 in 132*] She then asked: "*Why the 3? Is the 3 bigger than the 1? Why is the 3 bigger than the 1?* There was no response from the learners. Elrie then said "*1 is in the hundred column so it is bigger and 3 is in the tens column, so it is smaller as she pointed to the HTU columns. Now the 2 becomes 12 and the 3 becomes 2. What is 12 minus 6, 2 minus 1, 1 minus 0"?* She then asked learners to solve a similar example on their own, but most learners struggled to calculate. It became evident that learners did not grasp the concept. The explanation was not communicated in a procedural manner which prevented students from grasping the concept with understanding. Perhaps if Elrie used resources such as base ten blocks, unifix blocks or even counters to demonstrate how the tens could be deconstructed or exchanged for ten units the learners would have grasped the conceptual understanding.

In another lesson which focused on ordering numbers, Sam wrote the numbers on the board (70, 71, 17, and 76) asked the learners to order the numbers on their mini whiteboards from greatest to smallest? Some learners were confused with 17 and 71. Sam then repeated the instruction several times: "*Put the numbers in order. 'order' means that the numbers must follow each other".* The learners were still confused.Sam then asked, "*What is the number that is 3 more than 72? What is the number that is two more than 72*? What is one more than 72" As she asked the questions, learners wrote the answers on the whiteboard. Sam then asked learners to put the numbers in order and said, "*Remember the biggest number first. You have done this last year*". The learners still could not order the numbers. It could be that the questions Sam asked were not addressing the problem the learners actually experienced. Firstly the question required an understanding of the skill of ordering, and secondly understanding what "biggest to smallest" means; thirdly an understanding of the value of the position of the digits in the two digit numbers. Sam had to first identify the problem, and provide feedback to individual learners, which is a purpose of formative assessment. It became evident that the mismatch of the questions to the problem could be attributed to Sam's limited conceptual knowledge of place value.

Another example to illustrate the teachers' difficulty in communicating conceptual understanding was observed in Bela's lesson CO2/ Bela: "*A place is where something belongs. In maths, every number has a place. Does anyone have an idea of what value means? Value means, what it is worth"* Bela used the literal meaning of "place"and "value" to explain the mathematical concept of place value. Bela's literal explanation of the concept "place value" does not bring out the conceptual understanding of the concept of place value. Bela then went on to write HTU in columns and the digits in the number 236 in each column. As she asked learners the value of each digit, she pointed to the answer in the column e.g. "*What is the value of two in 236* (Teacher points to the number 2 and H to get the learners response of 2 hundred). She then writes down, 200+ 30 + 6. Bela was interested in the correct answer. This finding resonates with her belief expressed during the focus group interview when she stated that "*learning is about getting the right answer*".

Teachers' awareness of adapting teaching methods according to learners needs.

The teachers in the study are fully aware of the different teaching strategies and the need to adapt their strategies according to learners' needs. One teacher, Sue stated that when learners are actively involved in the learning process, they are able to construct meaning for themselves. Both Sam and Dona stated that they constantly use innovative strategies to help learners remember. FG1/ Sam: "*I often make up songs with repetition, children join in the chorus which is actually aspects I want them to remember*" and (FG2/ Dona): "*Take for example counting in two's. If you tell a learner to count in twos from zero to hundred, it sounds like a big task, but if you tell them the rule that when you count in two's you only use two, four, six, eight and zero, then it means that we made it much simpler. The numbers do not look as many; you only use five numbers, instead of 100*. Sue also stated that she used strategies that promote interest and collaborative learning (FG2/ Sue) "*Games make learning so much easier as learners learn spontaneously from each other in a fun way".*

Three of the participants mentioned strategies that help learners to make linkages between their existing knowledge or to what learners are familiar with (FG2/ Elrie/12) "*Bringing the real life into the classroom makes learning easier";* (FG1/ Bela/13) *"When I* *teach something that I know learners are not familiar with, I make up a story to link the concept to what they already know. It does not mean that the unfamiliar is more difficult to learn. It is about how it is taught. That is where I think my knowledge, my experience as a teacher then comes into play*"; and (FG1/Anna/15) "*learning is not only about acquiring new knowledge, but it is also about building on existing knowledge*". It therefore implies that if teachers want to implement formative assessment, they need to understand each learners' prior knowledge in order to help learners link their new knowledge to that which is familiar to learners.

Bela, Elrie and Sue also alluded to taking decisions in the moment by adapting the instruction according to learners' needs:

> FG1/ Bela 34: *"When I teach something that the child is not that familiar with, I then think on the spot about how I would take it over to the child in terms of what I say, how I say it and what I want him to do".*
>
> FG2/ Elrie/41*:* "*I think it is that moment when a teacher has to think immediately about how you are going to change your way of teaching. I can safely say after so many years of teaching, that every time I teach a certain thing, it is different because every year there is a different group sitting in front of me. Yes, today I am trying what I did last year because last year it worked, but suddenly you realise that it is not working this year. So, at that immediate point, you as a teacher, must have the ability to say, let's do it differently*"
>
> FG2/ Sue/43: "*When children ask questions which the teacher did not prepare for, we then change our way of doing things. Alternatively, you may quickly run into your storeroom and fetch something that you might use to help the learner understand. The strategies are there, but it's about changing your way of teaching at that moment"*

It became evident in the study that many of the strategies that teachers used, were not necessarily planned in advance, but emerged incidentally and in the moment according to the needs of individual learners. The study also showed that teachers are aware that a combination of strategies may be used in teaching mathematics in order to accommodate diverse learners. Elrie stated that most teachers use multiple strategies even without realising it. FG2/ Elrie/43 "*As a teacher, I plan to teach it this way using the aids. Then I* *have my own planned questions to guide the discussion. And then I have to show them the steps. We are pushing all those strategies to take care of those learners who are accessing the curriculum at the advanced level, those who can access the curriculum at the Grade level and those who need the support*". Interestingly most of the strategies mentioned by the teachers focused on procedural ways of teaching. Sam, for example, used strategies to help learners remember. This was evident in a lesson on comparison of numbers, where Sam used visual representations to help learners remember as she pointed to the closed and open-ended sides of the greater than and less than signs. To help learners remember, she told learners that the closed side points to the small number and the open side looks like a big mouth and points to the big number. To get the learners to remember the closed end and open end, Sam taught the learners a song with dramatisation: ***"****Close, close to the small number. Open, open to the big number, close, close to the small number".* Sam showed the learners cutouts of greater than and less than signs. She gave the learners a pair of numbers and asked the learners to place the smaller of the two numbers on the closed side of the sign and the bigger number on the open side. As the learners placed the numbers, they sang the song with repetition remember what they had to do. Sadly, teachers who mentioned the need to adapt the Instruction in the moment, which is an important formative assessment strategy, also turned to procedural ways of teaching.

Sam focused strictly on correct answers by reinforcing memorization through repetitition as illustrated in the following example. Sam drew three columns (HTU) on the chalkboard and used cardboard cutouts of single digits which could be pasted on the chalkboard. Sam picked up a number card, showed the card to the learners, then placed it in the unit column and asked learners to repeat after her, "*this is a six, the six is a unit, this is a six, and the six is a unit'.* Sam then picked another number card and placed the number in the ten column, and asked learners to repeat after her, "*This is a nine. The nine is a ten*". Sam placed another number card (number 1) in the hundred columns. The learners repeated: "*This is a one, a one is a hundred".* Through this activity, learners repeated several times after the teacher which resulted in memorisation, but no meaningful learning. Although learners were able to identify the place value of the digits through memorisation, they lacked conceptual understanding of place value.

This was evident in their workbooks where most learners got the activity on idemtifying place values of numbers incorrect. It became evident that procedural ways of teaching limits opportunities for learners to demonstrate their understanding, which then prevent teachers from enacting formative assessment.

Teachers' haphazard and non-coherent use of analogical reasoning in explaining concepts to learners

The study showed that many teachers made use of analogies in their teaching to link learners' new knowledge to their familiar knowledge. Data gleaned from the interviews showed that teachers' believed that learning is made meaningful when the new knowledge is linked to learners' prior knowledge and real-life experiences as evident in the following utterances: FG1/ Sam: *"Learning happens when you use examples of real-life experiences"; FG1*/ Sue: *"Bringing real life into the classroom through a story helps children to learn* and FG1/ Bela: *"If I use things that they know, the learning is easier. It is because they are familiar with it".* The above responses allude to the need for teachers to identify experiences that learners are familiar so that they can connect it to the unfamiliar concept.

The following examples of analogies used by teachers to gain insight into learners were observed: Anna explained how she used a story about friends to teach learners about place value: *FG1/Anna: "When we talk about 1, 2, 3, 4, 5, 6, 7, 8, 9 we are talking about units. Because that number is only one digit, it does not have a friend. However, numbers from 11 to 99 are two digits, means that they have one friend. Then numbers like 100 to 999s have two friends. When we talk of friends, they suddenly become so interested*".

Another teacher, Bela used the analogy of a house on fire to teach the concept of rounding off. She drew a number line from numbers one to ten on the chalkboard, which represented a neighbourhood with ten houses. She explained that only house number zero and ten have special people that can extinguish fires. She then posed the following problem to the learners: "*Suppose house number four is on fire, where do you think it's best for people to run to for help? Also, give me a reason for your answer."* Learners' responses varied. One learner responded, "*House Number zero, because it's quicker to run*". Another learner disagreed with learner one for the following reason. "*Teacher, not* *house number zero, because if the fire spreads, it will go quicker to house number four*" Another learner also agreed that they will run to house number ten *"because the fire will not spread so far to house number ten*".

Other learners gave answers such as house number five and house number six because these houses were closer and would be quicker to escape, being next door. Some disagreed with house numbers five and six because those houses could easily catch on fire because it is so close. The teacher then asked the class: "*Who thinks they should run to house number ten for help*?" Surprisingly, it was the majority of learners who raised their hands. Different reasons were provided such as: "*It is far from the fire"; "its okay for the house to burn if no one is inside*". The analogy of the house on fire engaged children in logical thinking about safety from fire but did not have a formative purpose, as the questions were inappropriate to the concept of rounding off. This is what I would refer to as "failed analogical reasoning".

In another example, Bela used the analogy of a house to explain the concept of "place value". Bela said to the learners, like people, numbers have a place to live in. This is evident in the following explanation: CO3/ Bela/3 "*In the number house, each number has their own rooms and live separately so that they don't fight*". She drew a picture of a house and columns to show how the rooms are separated and then explained, "*Each room has a name, i.e. thousands, hundreds, tens and units*" She then introduced the concept of rules to the learners. "*The number house has rules just like the rules that you have in your own house. The rule is that the rooms must be placed in a certain order from thousands, hundreds, tens and units. Secondly, the numbers cannot mix, so this means that each number lives in its own room*". She went on to explain what rules are, adding that sometimes rules may change under certain conditions. The questions asked by Bela elicited "yes and no" responses from the learners and limited learners' opportunities for critical thinking. The teacher herself answered most of the questions asked by the teacher. The discussions were clearly not assessment conversations but general discussions unrelated to the conceptual understanding of place value. In many instances, the analogies were used haphazardly, as teachers tried to simplify the concepts, which often confused learners.

The next theme deals with the professional aspects of being a teacher and how it shapes teachers' formative assessment practices.

4.4.5 Theme 6: Professional aspects of being a teacher are valued

Theme 6 is discussed under the following three sub-themes:1) Teachers value teacher agency in their pedagogical practices; 2) Teachers value further training and ongoing professional development 3) Teacher's value learning in professional learning communities.

Teachers value teacher agency in their pedagogical practice

Most teachers in the study expressed their frustration at the curriculum control by the Gauteng provincial department of education (GDE). Curriculum control in the GDE is regulated through the Curriculum Coverage Model (CCM) which includes Annual Teaching plans (ATPs). Teachers felt that the ATPs were prescriptive and does not take into account the individual needs of learners as expressed in the following utterances: (FG2/Sue/34): "*The ATPs is not learner-paced. Therefore, our teaching has become ATP paced. We are teaching for the officials. We do not consider the policies anymore. We can no longer decide on our own on what action to take based on our own current classroom situation*", and (FG1/ Bela/ 32) "*It's such a pity that we have no choice, but to go with the same content even though our learners are so different*". According to Sue and Bela, the ATPs and the curriculum coverage model prevents them from exercising their professional discretion in making independent choices according to the needs of their learners.

The study also showed that teachers view the regular accountability and reporting of curriculum coverage and school-based assessment to the department of education as an unnecessary act of compliance as stated in the following utterance: (FG2/ Dona/ 19): "*All that we do is impress the officials to show that we are covering the content. Actually, we are killing our learners. Most of the learners do not even understand the basic concepts. It's because we are chasing after curriculum completion"* and (FG1/ Nelly/ 16) "*If you report honestly, and show that you are behind, then you are seen as underperforming*". In response to Nelly, Sandy added "*Whether the learner understands or not, there is no* *time to stop and reteach*". Both Dona and Nelly alluded that their teaching has become an act of compliance.

The teachers were also of the view that the quality of their teaching was compromised, as they felt pressurised by the department and the SMT to provide proof of evidence of teaching as expressed by one participant: (FG1/ Kayla/ 29) "*I am doing it. Everybody wants that evidence. Proof! Why do you need that proof? Why? Why can't they trust us? We are teaching children, we are working, and we are developing them. Because of proof, we do n't want to teach what's not in our planning, even though it is needed*".

According to the participants, both the district officials as well as the SMT frequently asked teachers to present learners' books and lesson plans as proof of evidence that the work was done. Teachers' frustration at having proof of evidence was further expressed in the following utterances: FG1/ Bela/ 45 "*That's what they want, everything on black and white. We are doing it, but not everything is written down. For example, I once suddenly had a strategy and asked the children to take out their books to practice. Because it was not on black and white in my lesson plan my HOD asked me 'but where is it in your planning, it is not there'. That is what I am talking about. So now I teach only what's in my plan'.* Bela's response indicates that even when she decides on a strategy that could benefit a learner, she does not feel free to adapt, alter or substitute the strategies because it is not planned for. Two participants mentioned how their practical approaches to teaching were stifled because of the requirement for written work: (FG 1/ Anna / 25) "*To teach fractions, for example, you may choose to cut a page, somebody else may choose an orange. Even before you finish teaching the concept practically, you have to switch over to written work. Most of the time, they can show you practically, but cannot transfer this knowledge in written form. But we need this written work to show evidence*" and (FG1/ Nelly/18) *"It's difficult to show proof of practical work in mathematics. We are doing it, but we shorten the practical teaching so that it becomes a written activity to record evidence. Children can show you practically but struggle in their books*". Both Anna and Nelly showed that they valued the practical approaches to teaching, as learners were able to grasp the concepts with ease as opposed to the written application of concepts.

Kayla, on the other hand, reminds us of her moral responsibility towards her learners while having to comply with departmental regulations, which is evident in the following utterance: (FG1/ Kayla/ 31) "*You end up doing it, even if it is not on your plan for that day, because really it bothers you and you need to address it. Then you need to check along the way where you can just squeeze it in. That is actually, where you leave the ATPs aside and just focus on that. The problem is you are getting behind. You do not know where to really start teaching again"*

Teachers value further training and professional development opportunities in assessment

Teachers in the study were pleased that the in-service professional development workshops in mathematics offered by the district now offers training to teachers on both content and methodology. This was unlike in the past where in-service workshops focused mainly on content and disregarded pedagogy. However, teachers expressed concern that the pedagogical approaches were limited to mainly a single way of teaching and did not support teachers to address the diverse abilities of the learners. Teachers indicated that the workshops focus on whole class teaching and assumes that all learners have the same abilities as evident in the following response: FG1/ Bela/52: *Every workshop, they tell you what to teach and in some workshops, they will show you just one way to teach the concept, for e.g. how to break down numbers when adding two and three-digit numbers. But they never ever tell you how to teach learners with diverse abilities".*

In addition, Sandy also alluded to the need for assessment-related workshops to help teachers teach and assess learners with diverse abilities: FG1/ Sandy/43: '*We were never shown how to assess learners with diverse abilities in mathematics. We have learners in a Grade 3 classes who are working on a Grade 2 levels. So assessing them on a Grade 3 level when they are not working on a Grade 3 level, you not going to achieve anything. However, they in your class, you have to work with them and you have to assess them. This is where we need to be supported in"* Another participant, Anna, indicated that the assessment workshops offered by the district focused largely on the administration of assessment as evident in the following response: FG1/Anna/36: "All *that is discussed at the assessment workshops are due dates for submission of term plans, analysis of term results, reporting on curriculum coverage and common exams. Then* *they give us a template to complete the intervention plans to support learners. Why don't they show us how to plan the intervention, rather than how to complete the form?"*

It seems that the assessment workshops focused on topics related to summative assessment such as common assessments, recording of marks, analysis of term results. The six teachers who attended the AfL professional development workshops, which were facilitated by the programme co-coordinators, indicated that the programme has changed the way they teach; it has improved their planning, their communication with the learners and their role as teachers. The other six teachers who were trained by district officials were also positive about the workshop as it was for the first time that they had heard of these strategies. Despite their positive experiences of the AfL workshop, teachers highlighted some challenges that constrained their implementation of the strategies. A major challenge identified by teachers from the priority schools was their involvement in many other intervention programmes. The teachers expressed their frustration at being involved in many different programmes simultaneously, which not only increased their workload but also prevented them from implementing the strategies diligently. This sentiment was evident in the following responses: (FG1/ Nelly/23) "*Why don't the department just stop giving us so many projects. Leave us to teach at least for* 2 *years before adding on and changing"*; (FG1/ Sandy/ 24) "*Because we are classified as 'priority schools', we have become the target for the department. We are involved in almost all the interventions. It just too much for us, to do Math's, home language, First Additional Language and Second Additional Language"* and FG1/ Kayla: "We *have to teach the GPLMS lessons and then report on curriculum coverage. If we are not on track with the pacing of the ATPs, then you have to account. Now it is AfL. AfL takes time. It is because you are identifying needs and addressing it at the same time"*

From the teachers' responses, it appeared that both GPLMS as well as the ATPs which regulated the pacing of teaching, impeded teachers' formative assessment practices as it denied teachers the latitude and time to use the assessment data meaningfully in their instruction. Teachers also viewed AfL as an "add-on" to the curriculum and not as a complement to the existing intervention programmes as stated by one participant: (FG2/ Kami/32) "*And on top of it all we have to do AfL, follow the ATPs, and the other programmes. How can we do justice to teaching if we have to worry about AfL, ATPs, CCM?"* Teachers stated that their primary concern was to teach according to the pacing of the ATP's as they were being monitored on curriculum coverage continuously.

This finding was corroborated by the response of one of the district subject advisors who stated (DO/ Solly/13) "*There are so many workshops/ programme which are all done in silos. AfL is hardly ever factored into that. Ideally, what should happen is that somewhere, someone should say 'let us see how these strategies can fit into the existing projects we have".*

Another finding that emerged from this study is the lack of monitoring and support of the implementation. I observed that teachers do not enact the AfL strategies, but they talk to the children about it. This was evident in the way Sam introduced the learning outcomes and the success criteria to the learners at the beginning of the mathematics lesson. Sam had the following labels written on the chalkboard to make the learning intentions and success criteria explicit to learners "*WALT- We are learning to…"* and "*WALF- We are looking for".* In the first lesson, Sam said to the learners: "WALT means *we are learning to….. and WALF means we are looking for…..We are learning to put 3 digit numbers in the correct place".* She then wrote on the chalkboard and asked learners to read repeatedly. Next, she went on to state the success criteria as follows "Let's *look at the success criteria. We will put the numbers in the correct places and break the numbers into units, tens and hundred."*

The similar observation was made in the subsequent lesson when Sam wrote out the learning intentions on the board as follows: *"Our learning intention is to order, describe and compare the numbers from biggest to smallest and smallest to biggest".* She then said to the learners: "*Our success criteria is what we are looking for"* and then wrote the success criteria on the chalkboard: "*Put the numbers in order from biggest to smallest and use the signs*". Teachers focused on procedural ways of teaching and assessed how well learners learnt the steps or procedures, rather than assessing learners' understanding of the concepts. Sam articulated the success criteria to her learners as follows "*You know that you achieved the outcomes if you can follow the steps correctly when adding and subtracting*". Sam also used the meta- knowledge she acquired during the professional development workshops in her communication with the learners as evident in the following excerpt taken from the transcript:

CO2/ Sam/13: "*Now let's see whether you have understood the lesson. What did we learn today?"*

Learner: "*Place value".*

CO2/ Sam/13: "*What else? (No response from learners)*

Remember you must look at the learning intentions and success criteria. Do you think the success criteria have been achieved? Can you order the numbers from the smallest to the biggest? Can you order, describe or compare the numbers? (Long pause… No response from learners) Can you? (Long pause…No response from learners). *Therefore, what you have done here is what is stated in our success criteria. We put numbers from smallest to biggest. That is our evidence that we achieved the learning intentions.*

During the recap of the lesson, the learners' responses to Sam's questions were poor which could be attributed to Sam communicating in a manner that learners could not understand. In contrast to Sam, Sue simplified the learning intentions for the learners using learner friendly terms. The learners in Sue's class had a clear understanding of the learning interntions and were much more interactive and responsive than the learners in Sam's class.

The data also showed that there was poor school and district level support to assist teachers with effective implementation of strategies. Subject advisors from Tshwane South District were trained on AfL strategies but found it difficult to support and monitor teachers' implementation of AfL in mathematics as the training was generic and not mathematics specific. Subject advisors were expected to demonstrate the implementation of AfL in mathematics classrooms, however since they were not mathematics specialist they found it difficult to teach mathematics due to their limited subject matter knowledge. One subject advisor remarked (DI/ Solly/19) "*It's not easy to go back into the classroom after 15 years and start teaching mathematics. So many things have changed along the way, the content, strategies, etc. Teaching mathematics is not only about using the techniques".* Solly's utterances suggest that the successful integration of AfL strategies in mathematics requires a sound subject matter knowledge. On the other hand, Wendy, who is a mathematics specialist stated that the lesson demonstrations were most effective in supporting teachers' practices. This sentiment was expressed as follows: DI/ Wendy/ 12

"*Even the teacher who have been teaching for many years, admitted that she learned so much by observing my demonstration lesson. I also learned about what works, what doesn't work as I interacted with the children. I can support schools from an informed position because I have experience in practice".*

Another challenge experienced by subject advisors with regard to supporting, montoring and evaluating the implementation of AfL was that they were involved in too many intervention programmes simultaneously within the district. This sentiment was explicitly stated as follows: DI/Solly/14: "*There are so many workshops/ programmes. Even when it comes to the materials or manipulatives, it is there, all in their cupboards. Teachers have a lot of them. However, they do not know which ones to use. It is the same as the strategies. You can give the teachers all the strategies, but they do not know when to use what strategies";* and DI/Wendy/23 "*This is just one of the many projects the District has. There are so many other projects, and interventions running concurrently. It is very difficult to focus just on AfL. Like the teachers, we monitor a bit of everything [all the projects] Therefore on our side …monitoring, yes we do, but support, there's very little support".* The problem of having too many projects or programmes running concurrently resulted in subject advisors' monitoring becoming a tick- box exercise as stated by one participant: (D1/ Wendy/ 22) "*All I check is where is your plan, AfL, etc. The teacher tells she does it. However, when you go into the classroom, you do not see evidence of these happening. I can tick or cross and say everything is hunky dory. However, when you go into the classroom, it's not there".* The district officials also affirmed that their monitoring focuses extensively on formal assessments as opposed to formative assessments as expressed in the following response: (DO/ Solly/17) "Nowhere *do we say show me what you do as a formative assessment to improve teaching, but we ask them 'show me your formal assessment plans. How far are you? Let's see the recording'. For teachers, if they can produce evidence it is as they are doing their work."*

The implementation of AfL varied from school to school. In some schools, all teachers and learners were fully engaged, while at other schools, only a few teachers were engaged. While the training was intended for both HoD's as well as selected teachers, at some schools, HoD's did not attend the training. One of the reasons for HoD's not attending the workshops is that the dates for workshops clashed due to the many different intervention programmes that schools were engaged in. Hence, HODs delegated their responsibilities to other members of staff to attend the workshops. In schools where HODs did not attend, there was a lack of commitment due to the poor support and monitoring. One district official stated, "*The cascading of the training did not take place effectively. In schools where HODs attended, there was greater commitment. The training was never cascaded to other Grades within the schools*". Professional development became most effective in schools where school management understood the need for professional development and actively participated in it. These differences indicate the level of the challenge for leadership and support, and particularly for the development of differentiated strategies for professional development.

Teachers value learning in professional learning communities

The teachers in the study indicated that the professional learning community (PLC) meetings had immense benefits. Since the mainstreaming of GPLMS, it was for the first time that teachers were left to plan independently for mathematics teaching without the support of GPLMS coaches. In the past five years, teachers had GPLMS coaches who supported teachers in their planning as well as in their classroom practice to implement the GPLMS programme. In addition to planning on their own, teachers had to now plan to integrate AfL strategies in their lessons. Teachers stated that the integration of AfL strategies is demanding, as it requires thoughtful planning. It required teachers to adapt the existing GPLMS lesson plans so that AfL strategies could be meaningfully integrated. The GPLMS lesson plans outlined the content to be taught but did not make the success criteria explicit which was essential for AfL. Teachers, therefore, discussed content knowledge during the PLCs to help teachers to identify the success criteria. Furthermore, teachers expressed concern that AfL was time-consuming and they were already pressurised to complete the number of activities in the GPLMS lessons as evident in the following response: FG2/ Anna/ 13: "GPLMS *already has so many activities to complete and now it's AfL. AfL is so time-consuming, we cannot get through everything in a day*".

Teachers indicated that the PLCs were valuable as they discussed content knowledge, teaching methods, how to improvise resources to support their teaching and reflected on their practice.

The teachers mentioned that the AfL workshops were generic and provided teachers with the theoretical knowledge about assessment and was not specifically related to the subject mathematics. The PLCs provided teachers with support through regular discussions and sharing of ideas. One participant, Elrie highlighted the value of watching a demonstration lesson to improve teacher's practice. Elrie described her experience of observing a teacher demonstrate the AfL strategies in a mathematics lesson at one of the professional development workshops as follows: FG1/ Elrie/ 26 "*And for me, until today that was the best learning experience I ever had because it was a teacher from a school that stood in front of us. She understood the learners, she understood what was going on, and she understood the Grade 3 curriculum*"

In addition, concerns arising from the lack of subject-specific training in AfL was corroborated by the district officials as expressed in the following response: DO/ Solly/16: "*If they trained teachers exactly how to identify the success criteria specifically in mathematics, they [teachers] will probably implement better. This is not easy for teachers to do on their own. In fact, even we, as district officials are struggling*". It became evident in the study that teachers were dependent on collegial support to integrate the strategies in their mathematics teaching. Hence the PLCs helped teachers to integrate AfL strategies into their mathematics lesson planning. One participant, Sue, explicitly stated that formative assessment requires more than knowing about the AfL strategies as stated in the following response: (FG1/ Sue/31) "*Knowing about AfL strategies is not enough. Teachers need the content knowledge as well as appropriate methods to teach mathematics".* Sue, therefore, ensured that the PLCs include topics such as content knowledge, teaching strategies and teaching methods specific to mathematics. Sue stated that regular meetings are held to discuss lesson preparations, how to make and use teaching resources and how to integrate AfL strategies in their planning.

The commitment of teachers was highlighted by Sue in the following response: FG2/ Sue/ 34: "*Teachers attend the PLCs with such dedication. They make time to come knowing that they are going to benefit*". Sue also added that effective implementation of AfL strategies required the use of appropriate resources as she explained, "*You cannot implement the AfL strategies without resources.The resources are not there, so teachers have to improvise or make their own resources"* The teachers also share ideas on how to make resource teaching. The teachers not only shared ideas on how to make resources but at times, they also made the resources during the meetings. Sue shared the following in this regard: "*We often share ideas and make resources at the PLCs. We do it at the meetings because when we go home, we forget about. At the last meeting, we made place value mats for each learner*".

According to Sue, their professional learning communities meetings were helpful in sharing challenges, good practices and making resources. Teachers valued these opportunities for sharing ideas with other teachers, time for reflections, and support for teaching new classroom activities. Elrie stated that during the PLC meetings, they shared lesson plans and showed teachers how to develop lesson plans as expressed in the following statement: (FG2/ Elrie/18) "*There were some schools that couldn't even plan a lesson but through the PLC meetings you could sit with them, and help them. You cannot expect teachers to implement AfL without having a plan for what you are going to teach".*Teachers also identified time as constraint in attending the PLCs. Teachers in the priority schools were involved in too many district interventions simultaneously and therefore the teachers could not attend the PLCs regularly. In addition, teachers were also involved in too many school activities that clashed with the PLCs.

4.5 **CONCLUSION**

This chapter focuses on the analysis and presentation of the data collected during the investigation. Various themes and sub-themes are presented in this chapter which explains teachers' formative assessment practices in mathematics. The findings showed that while teachers' have some awareness of the essential aspects needed for the enactment of formative assessment to improve learning, they struggle to enact formative assessment because of specific factors that impact on the activity of the classroom. Teachers are aware that learning is a process; that learners' engagement in class contributes to meaningful learning; but they struggle with the enactment. Although the study showed the presence of positive perceptions towards quality formative assessment, the practice was found to be inconsistent. Perhaps, this may be because of the predominantly summative assessment tradition and the reluctance to use quality formative assessment.

CHAPTER 5

DISCUSSION OF FINDINGS

5.1. INTRODUCTION: FORMING LEARNING THROUGH SPONTANEOUS ASSESSMENT

In the description of the process of data analysis in the previous chapter, the empirical text showed how the central finding was constructed from an array of codes, categories and themes. From the interpretation of the various themes about how teachers implement formative assessment practices in their teaching. I have come to the conclusion that the term 'formative assessment' may be presented to teachers as assessing, evaluating or even testing, instead of simply an integral part of daily teaching practice. To that end, I forward the notion of 'formative pedagogy', which, I would argue, may have more currency with teachers. I argue that the evidential warrant for this does not only come from the empirical text of Chapter 4, but also from the literature. In my quest to find how teachers do this work of 'assessment for learning,' I found that they do 'implement' the techniques, but that this implementation does not feature in an integrated way. My sense is that it may be because the emphasis in the term, 'formative assessment' is on assessment, and less on the forming of a pedagogy in which learning is the key focus. I would also argue that such assessment practice originate from a spontaneous awareness of where individual learners are on the ladder of progress as well as groups or a whole class.

Hence, when I reflect on the sub-questions of the thesis, I realise that the data of the empirical text has shed some light on all the questions, with the third and fourth questions having become, for me, the most prominent. I argue that *if teachers knew more about mathematical cognition and development of children's concepts, that they would have practiced 'formative assessment more intuitively,* and less technically, pitching their feedback at the level of the individual learner's (and groups') 'misunderstandings.'

1. How do Grade 3 teachers understand formative assessment and its purpose?
2. What explains Grade 3 teachers' formative assessment practices in Mathematics?

3. What do Grade 3 teachers know about how children learn mathematics and how their conceptual and procedural understanding develops?
4. How do Grade 3 teachers use their knowledge of children's' thinking to shape their formative assessment practices in mathematics?
5. How do Grade 3 teachers experience the professional development of formative assessment?

The themes from the data analysis process have been interpreted broadly from the epistemological position of Cultural Historical and Activity Theory (CHAT), which serves as the heuristic framework of this study. I begin by providing a brief overview of CHAT as a framework to highlight the linkage between the *activity* of formative assessment and the role of the different components of the bounded system of the teachers in their practice of formative assessment in mediating learning. Using CHAT as an analytical tool, the findings of the investigations are interpreted according to the thematic clusters presented in Chapter 4. These themes are complex and interlocking. Together, all six themes illustrate, in an integrated manner, how the activity of formative assessment, as the Grade 3 teachers defined and practiced it, centred on learning that is situated and relational. In the discussion, I combine the empirical text and the relevant theoretical knowledge by 're-contextualising' the emerging data with literature (Henning et al., 2004) to argue the distinctive contribution of formative assessment in enabling effective teaching and learning of mathematics. The discussion of the data reflects my own interpretation and includes the voices of the participants and the conceptual framework of the study.

5.2. AN INTERPRETATION OF FORMATIVE ASSESSMENT PRACTICES THROUGH THE LENS OF CHAT

In this section, I provide a brief explanation of the elements of CHAT that I draw upon in discussing the findings of the study. The 'activity system' consists of Grade 3 teachers' pedagogical practice of engagement with the 'activity' of formative assessment with the goal of helping learners learn mathematics successfully. The following six elements of the activity system (Figure 5.1 below) are interpreted: 'tools', 'object', 'rules', 'division of labour', 'community' and 'subject'.

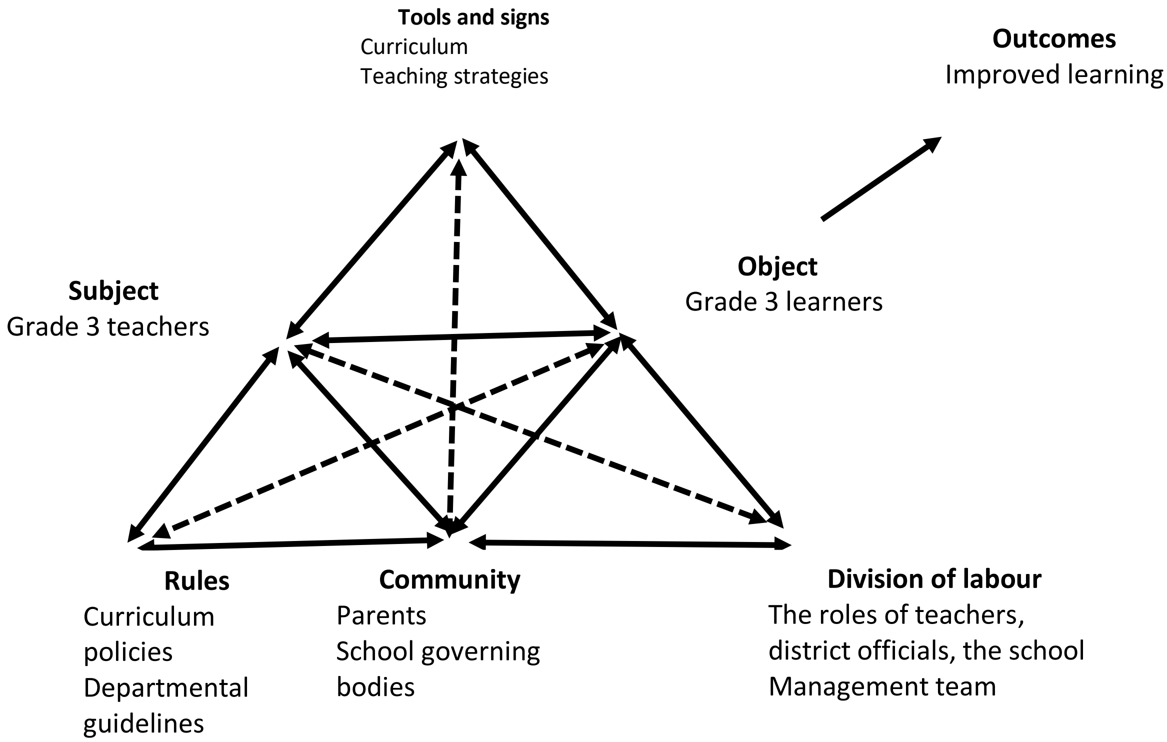


Figure 5.1: Formative assessment as a CHAT activity (Adapted from Engeström, 1999)

The *object* component includes the Grade 3 learners. The unit of analysis in the study is Grade 3 teachers' classroom practices. The *subject* of the system is the Grade 3 teachers and the *outcome* is the desired goal, which is improved learning of mathematics of the'*object'* the learners' learning through formative assessment. The *division of labour* refers to the roles and responsibilities of the stakeholders such as subject advisors, the school management team and teachers. The subject advisors and the foundation phase HODs were also part of a systemic activity system as their responsibility was to offer support to teachers as subjects. Within the classroom system, the study of the *division of labour* is significant as it specifies the power relationship. This is manifested in the teacher's authority to establish learning goals for learners, select and design learning activities, establish performance criteria and measures, and dictate behaviour standards. The *rules*, which may be either explicit or implicit, are significant as it specifies norms and expectations for behaviour. In particular, these include the teachers' and learners' deep- seated, often unconscious models of what school teaching and learning 'should look like,' as well as implicitly negotiated (and often tested) thresholds of acceptability for borderline behaviours. The *community* included the parents, school governing bodies, cultural context and social context. Finally, the *tools* of the system include the different techniques, strategies and resources employed by the teachers to enact formative assessment practice. The activity system's tools include a wide range of teaching/learning resources, ranging from concrete items like whiteboards, worksheets, workbooks, manipulates, counters, to abstract patterns of action such as activity types, assessment for learning strategies, teacher questioning strategies, and recourses for disciplinary action.

Included in the discussion of each theme are the tensions and contradictions that emerge with the activity system of the classrooms. As previously noted, contradictions are "springboards" that alter the subjects' practices, and they offer a possible explanation for this dynamic nature (Engeström & Miettinen, 1999: 9). They are a characteristic feature of all activity systems, and are not identified as a problem, but rather as "the motive force of change and development" of the formative assessment activity (Engeström & Miettinen, 1999). My intention in linking the themes with their respective contradictions is to present a realistic picture of the Grade 3 teachers' formative assessment practice as messy and contextual bound.

In an attempt to identify the dominant contradictions inherent in the themes that were constructed. I read each theme summary several times and identified contradictions, some of which overlapped in themes. I organised the contradictions into the different components of the activity system by using six different coloured post-it notes (a colour for each theme) as it enabled me to see where the greatest tensions existed. I found that most of the contradictions related to rules of the classroom system. While CHAT provides a structure to understand how teachers' instructional practices are influenced by the various components of a classroom as a system, the co-evolution model makes explicit two propositions implicit in CHAT: the subject and the object are in constant, interlinked evolution, and tensions between the elements of this system drives practice.
In the next section, I present a discussion of the findings of the study.

5.3. DISCUSSION OF THE FINDINGS

The findings will be discussed according to the six themes, referring to CHAT theory. The discussion is supplemented where pertinent with other applicable literature. The work of Black and Wiliam (2009) is also used as an additional lens to analyse teachers' practices of formative assessment. In relation to the research question, the following themes were composed as the main findings:

- Teachers have some awareness of learning as being a process, while at the same time thinking of curriculum requirements.
- Teachers' awareness that learners' attitude and learning are positive about engaging in class.
- Teachers have some awareness of skills and strategies to find out if learners have learnt something.
- Teachers' limitation and usability of formative assessment in improving learning.
- Teachers have limited conceptual knowledge of mathematics and how to communicate them clearly and coherently in instruction.
- Professional aspects of a teacher are valued.

5.3.1. Theme 1: Teachers have some awareness of learning as being a process, while at the same time thinking of curriculum requirements

Most teachers in the study showed an awareness that learning is process oriented and mentioned that learners need multiple learning opportunities in order to understand a concept with meaning. This finding resonates with the claims advanced by Gearhart and Saxe (2004) that quality teaching of mathematics requires teachers to engage in ongoing assessment of learners understanding to identify learners' misconceptions, and a commitment to knowing what learners know. To my surprise, none of the participants mentioned the role of formative assessment let alone assessment as being part of the learning process, yet they are aware that learning does not occur through a single act. I had to probe the participants to elicit responses on the role of formative assessment in the learning process. Only after being probed did some teachers mention the use of informal assessments such as observations and questions in gathering evidence about learners' understanding. Most participants mentioned just one or two aspects of formative assessment process but none could explain, let alone practice how it was used in the learning process to improve learning. Interestingly, teachers who enacted one or two aspects of the formative assessment process believed that they were implementing formative assessment. This finding is consistent with Brookhart's (2007) findings which showed that teachers view the components as being unrelated to each other and believe that they are implementing formative assessment.

I therefore concluded that teachers enacted formative assessment haphazardly by enacting parts of the formative assessment strategies in a disconnected manner, rather than linking the strategies coherently to improve learning. Formative assessment in practice, as explained in section 2.3.2 includes multiple activities ranging from eliciting evidence about learner achievement, interpreting the evidence and using the evidence to make instructional decisions to improve teaching (Black & Wiliam, 2009).

The haphazard implementation of formative assessment could be attributed to a range of variables, identified as tensions and contradictions within the activity system of the classroom system, which prevented the pedagogical use of formative assessment during the learning process. This theme is discussed under the following subthemes:

Learning is dependent on learners' prior knowledge and skills

Teachers in the study bemoaned that most Grade 3 learners lacked the previous grades knowledge and skills which prevented learners from achieving the Grade 3 learning outcomes. This finding supports previous research (Spaull & Kotze 2014) which suggests the importance of learners' prior knowledge in understanding complex concepts as explained in section 1.1. It became evident in the study that teachers were able to identify and pinpoint learners' learning needs during the daily mathematics activities (questions, practical activities and oral discussions), but often did not address these learning deficiencies. This finding may be explained by the fact that the learning gaps were not linked to Grade 3 learning outcomes, but emanated from the previous grades. Most of these learning gaps required reteaching of the concepts, which was difficult for teachers to accomplish, as they had to keep track with the pacing of the prescribed ATPs. Another possible reason is that teachers are pressurised to complete the content and therefore find it difficult to adapt to the "unplanned teachable moments" resulting from formative assessment, referred to as "moments of contingency" (Wiliam & Leahy, 2007) as explained in chapter 2. Furthermore, teachers seem to think that it is not their responsibility to address the knowledge gaps from the preceding years, yet it is one of the key roles of formative assessment.

Another reason for teachers' limited opportunities to understand learners' prior knowledge during the process of learning is the policy requirement which stipulates the number of formal assessment tasks at the end of a learning unit. It is crucial for teachers to understand the learners' prior knowledge as the need arises in order to offer timeous support which in Heritage's (2010) term is referred to as a "pop-up" lesson to clear up a misconception before proceeding with the planned instructional sequence. In addition, opportunities for open discussions or instructional conversations during the learning process were limited. The importance of assessing learners during the process of learning to assess learners' coherent reasoning, rather than solely relying on assessments at the end of a learning unit was advanced by scholars such as James (2006); Pellegrino et al. (2001); Shepard (2008) and Wilson (2008) as discussed in section 2.6. These claims were further supported in studies by Heritage (2010), Oxenford O'Brian, et al. (2010) and Shepard (2000) who found that teachers often disregard the evidence of learners' errors, misconceptions and misunderstanding from the formal assessments. I argue that diagnosing learners' misunderstandings and making instructional decisions during the learning process is an important component of formative assessment which is unfortunately downplayed in many classrooms. The importance of learners' prior knowledge was also highlighted in chapter 2 where I analysed the role of learning progression in formative assessment (see section 2.5.1.) In section 2.5.2, I established how learning progression contributes to formative assessment (Black & Wiliam, 2006; Briggs & Peck, 2015; Clements & Sarama, 2015a). Hence, the findings in the study show that teachers' limited use of formative assessment to address the learning gaps of the Grade 3 mathematics knowledge among learners is attributed to the concerns that most learners lack the foundational knowledge and skills from the previous years. Given that mathematics teaching requires a systematic, sequential approach to the development of concepts as noted by Clements and Sarama (2015b), it therefore becomes incumbent on teachers in Grade 3 to teach the previous year's concepts to Grade 3 learners who lack the foundational knowledge in order to advance in their teaching. Unfortunately, this is not the case as most teachers tend to focus on the Grade 3 curriculum only. I therefore argue that if teachers are to enact formative assessment they need to operationalise the concept of learning progression, which articulates a clear connection between what comes before and after a particular point in learning as discussed in section 2.5.2. An understanding of learning progression will enable teachers to calibrate their teaching by including precursor knowledge and skills which may be revealed though formative/summative assessment, as well as to determine the steps needed to move the learning forward.

In trying to understand the tension resulting from learners' lack of prior knowledge, I looked at this trend from the perspective of CHAT. Within the activity system of a classroom itself, the division of labour component suggests that different stakeholders have a role in contributing to the effective implementation of the system. In this regard Grade 1 and Grade 2 teachers have a responsibility to ensure that learners have a thorough grounding of the curriculum so that they are adequately prepared for Grade 3 work. A thorough understanding of Grade 1 and Grade 2 and knowledge will allow Grade 3 teachers to focus on the Grade 3 curriculum requirements. It was also evident that the teachers in the study tend to teach according to the prescribed pacing of the ATPs irrespective of the developmental needs and abilities of learners [yet again the impact of rules (CHAT) compromises flexibility and pacing the curriculum].

A possible explanation may be that teachers are forced to adhere rigidly to the pacing of the ATPs as they have to report on the progress of curriculum coverage. Instead of addressing learners' needs, teachers seem to be chasing after the curriculum for the sake of compliance. As postulated by Clements and Sarama (2014: 4) that "deep conceptual understanding of mathematics occurs developmentally", I argue that this implies that foundation phase teachers should have a thorough understanding of the curriculum across the phase to teach developmentally. I suggest that teachers' curriculum knowledge across the grades could be strengthened if all foundation phase teachers could work collaboratively to develop their thinking together as they plan, share ideas, strategies, observation and solutions.

Teachers can then use the information gathered as part of formative assessment in order to scaffold the child's future learning opportunities and differentiate teaching strategies to meet individual learner's needs.

An explanation of learning progression through the perspective of CHAT, positions this construct as an important mediating tool. In this study, teachers found it difficult to move backward and forward along the progression trajectory, even though formative assessment results showed that learners were missing key building blocks of conceptual understanding and application. These knowledge gaps required teachers to revise or even re-teach the associated concepts, which did not happen. It is my belief that most teachers do not see it as their responsibility, yet this is what formative assessment is all about. They tend to shift the blame to the Grade 1 and Grade 2 teachers. Considering the claim advanced by Heritage, Kim, Vendlinski and Herman (2009: 31) that, "Until teachers have better conceptions of learning and deeper knowledge of how the elements of learners' learning are manifested, then the transition from evidence to action as a seamless process will remain a somewhat a distant goal", I argue that every effort must be made to devise lesson plans that effectively underscores learning progression as explained in section 2.5.3.

This finding suggests that if teachers are to implement formative assessment, they need to collaborate with other teachers within their grades as well as across grades. There is some collaboration within cluster level in the district of Tshwane South, which could be explained as "community" through the perspectives of CHAT. The teachers highlighted the monthly cluster forum meetings as valuable where best teaching practices, formative assessment practices and issues around classroom management are shared and furthermore that interventions to particular teaching challenges are discussed and appropriate solutions are shared to mitigate teaching and learning strategies. I argue that Grade 3 teachers should have a thorough understanding of the curriculum across all Grades in the foundation phase so that teachers can address the knowledge gaps.

Learning is enhanced when learners apply knowledge in varied contexts

Teachers' understanding that learning is strengthened when learners are presented with opportunities to apply the knowledge and skills in varied context suggest that teachers value the transfer of knowledge as well as the integration of concepts in learning in a seamless manner. This sentiment was amplified by Skemp (1987) and was analysed in section 2.5.2 of chapter 2 where the issue of relational knowledge is crucial to deduce specific rules or procedures from more general mathematical relationships. For example, during the focus group interview, one teacher (Kayla) described how the knowledge of fraction is required to understand the concept of time, specifically half hours and quarter hour which suggests her awareness of establishing connections between concepts. Kayla alluded that most learners know a concept in one context but struggle to apply the concept when asked in another context. I draw upon on the work of Stiggins (2010) as noted in chapter 2, who provided three possible reasons that could explain this challenge / anomaly. Firstly, learners are not yet fully competent as they are still in the process of learning; secondly the support structures that were available in the familiar context are no longer available in the new context; and thirdly, learners tend to master the classroom routines, but not the underlying concepts. Hence, I concluded from this finding, that teachers need to implement strategies that can foster deep understanding, which is flexible, adaptable and generalisable, rather than memorisation.

Furthermore, I contend that teachers need to be more astute in understanding the pivotal role that formative assessment can afford them to instil a culture of deep learning, learning for understanding and learning for application. One way that this can be promoted is through activity based formative assessment where teachers can gather evidence to ascertain the extent to which learners are achieving the learning outcomes for particular parts of the mathematics curriculum in the early grades. In support of the contention I made above, I draw upon the views of Shepherd (2013: 27) that “Good teaching constantly asks about old understandings in new ways, calls for new applications, and draws new connections”. There can be no doubt about the fact that learners would benefit significantly if teachers enacted and understood formative assessment as a strategic enabler to effective learning, which in turn will enable teachers to identify knowledge gaps and adjust their instruction / teaching methods accordingly.

Consistent with the views of CHAT, is the notion that learning is a mediated activity with tools. However, the finding in the study showed that the participants relied predominantly on the use of procedural strategies such as drilling. It became evident from my observation and feedback from the interviews with the participants that learning was increasingly becoming a conditioned response and dominated by strategies that encourage rote learning, passive learning, surface learning and memorisation. This goes totally against the principles of social cultural learning (Bruner, 1996; Copeland, 1984; Ginsburg, Inoue & Seo, 1999) as was analysed in section 2.7 (learning theories).

During the classroom observation, I found that the greater part of the mathematics lesson focused on drilling to rote learning the correct answer to the detriment of teaching for conceptual understanding. The possible reason for this practice is that teaching has become answer driven because teachers' performance is evaluated by learner's performance. Even the formal assessment tasks showed that most of the questions were recall type instead of application questions. Learners' dependency on procedural strategies used in teaching, inhibited learners from acquiring deep learning which they could transfer to other contexts. This could be a plausible reason why many learners in Grade 3 have a weak grasp of conceptual understanding of the mathematical learning outcomes.

I found that the "rules" inherent in the multifaceted policy environment and the departmental guidelines that regulated teacher's classroom practices compromised their ability to become innovative and implement formative assessment flexibly to cater for individual learners' needs. Teacher's rigid adherence to the departments' guidelines for curriculum coverage and school based assessment hindered teachers' formative assessment practices. Hence, teachers usually taught the assessments that were included in the formal assessment tasks and disregarded the mathematics outcomes.
To fast track curriculum coverage and keep up to speed with the suggested guidelines of pacing, learners were taught to remember the steps and procedures they could use to answer the formal assessments.

As a result, many aspects of the curriculum were disregarded and dissected irrationally. This finding contradicts Mavrommatis (1997) model of iterative steps involved in an assessment episode as explained in section 2.3.3. A possible reason to explain this occurrence may be that teachers feel pressurised to produce good results, as they have to report to the district on the performance of the learners as well as the curriculum coverage twice a term. Schools that show that learners are underperforming became target schools for district intervention. This finding resonates with Earl (2012) who opines that the increasing pressures imposed on teachers to account for learners' performance have shifted the focus of learning from a process - oriented activity to a performance measurable activity. Similarly, a change in their view of learning has resulted in assessment practices being modified. Formative assessment within this perspective is weakly conceptualised as with diminishing focus on the social interaction of learning as explained in the discussion of socio cultural learning theories in section 2.7.5.

Learning is a complex activity

Participants' in the study are aware that learning is a complex activity because of the diverse needs of learners. With this in mind, participants are aware that it is most unlikely that all learners will have learnt everything in the set time. This is because learning does not usually happen at one time, or at the same time for everyone as ideas develop in each learner at a different pace. This requires multiple opportunities for learning as learners develop over time. Furthermore, in a subject like mathematics, which is hierarchical in nature, there are certain basic concepts and skills that must be mastered before the next set can be learnt as they provide a foundation for the next level. If the prerequisite step is not in place, the next level will not be learnt and the gap in required knowledge and skills will increase. This therefore leads to a need to know where different learners are in their learning, and what the pre- requisite skills and knowledge are that everyone should understand and be able to do before they can move on to the next level of learning. It is for this reason that formative assessment is so important to ensure that learners have a thorough understanding of what is covered in the curriculum. In this regard, the participants were highly critical of the provincial department of education citing that the ATPs do not take into account the diverse context in which they teach as it expected teachers to mediate standardised lessons. Through the perspectives of CHAT, I view prescribed lesson plans, the curriculum coverage model and the ATPs as mentioned in chapter 2 as the "rules" which regulated teachers' teaching. I argue that since learners' development is not linear and does not follow a predetermined route, teachers need to use multiple teaching strategies to respond to the diverse needs of learners. The participants in this study however indicated that they do not have the flexibility to adapt their instruction as their teaching is regulated by departmental guidelines such as the ATPs and policy prescriptions such as CAPS as they taught to pacing and not according to learners' needs. This implies that teachers are aware of the importance of considering learners' needs but are unable to innovate due to the "rules" imposed by the education authorities. Drawing on the study of Popham (2009) who noted that learning is differential and may lie at different points along the learning pathway for different learners, I argue that the differences in the way learners' progress and develop also has untold implications for instruction and assessment. Teachers therefore have greater responsibilities for designing tasks and learning activities to mediate the curriculum, for constructing criteria to help unpack the tasks. When reviewed from the CHAT perspective, and specifically from a "systems gaze" one can argue that the "rules" of the curriculum and its policy directive formatted teachers' engagement in the classroom in a narrow and egotistic way.

Even though teachers were able to identify difficulties along the learning pathway, which is a significant purpose of formative assessment, they were restricted from re-teaching these concepts for fear of lagging "behind" in their teaching. While teachers are aware that a "one size fit all" plan does not meet the needs of all learners, teachers struggle to adapt the plans according to learners' needs. A possible reason could be time as many participants felt that the lack of time for teaching for understanding amongst learners was compromised by the regulations set down in the prescribed curriculum. The diverse ethnic and cultural makeup of today's classrooms makes it unlikely that one size will fit all learners. I argue that although the lesson plans ensure curriculum coverage, it is does not make provision for formative assessment because it legitimates the notion of a standard pace of learners' learning.

Methods of teaching which assumes that all learners learn in the same way and pace are irrelevant for formative purposes. Some contradictions were observed from participant's responses as to what they construed as good teaching from the side of the school management team and the school district. In my lesson observations, I noticed that in most instances, teachers' practices conformed rigidly to the guidelines prescribed by the departmental curriculum requirements and prescripts. Teachers were unable to innovate and 'think out of the box" for fear of not covering the content prescribed in the curriculum by the department on time. I further observed similar findings as reported by Copeland (1984) that teachers tend to select pedagogical methods that would “cover” the curriculum the quickest way at the expense of selecting pedagogical methods that were effective to reinforce teaching. Such conflicts created a tension-filled school environment in which teachers felt pressurised to comply. Together with the prescriptions, schools were held accountable for learners’ performance. As a result, I observed an overemphasis on summative assessments (DoE, 2011a as discussed in chapter 2) by teachers as assessment provides the evidence of success on the part of learners, teachers, and the system. Schools that performed well in the common assessment were categorised as ‘non-priority” schools and were subjected to fewer district interventions while schools that performed poorly in the common assessments were categorised as “priority schools”. The overemphasis of summative assessment could be another possible explanation for the underutilisation of formative assessment.

The finding presented in this section showed that while teacher’s have some awareness of the role and significance of formative assessment, they are reluctant to embrace formative assessment optimally because of time constraints; flaws in the curriculum design; weakness in how the pacing of teaching the curriculum is prescribed in CAPS (DoE, 2011a), poor support from the SMT and school district, conflicting views from the SMT and school district on what constitutes good effective teaching.

5.3.2. Theme 2: Teachers are aware that learners’ engagement in class contributes to meaningful learning

When reviewed from a CHAT perspective, one can argue that the “rules” of the classroom and management structure formatted both teachers’ and learners’ engagement in the classroom. It became evident in the study that teachers have the strategies (tools) and techniques to engage learners in collaborative learning, but find it difficult to operationalise these strategies in their pedagogical practice for formative use.

In my analysis, I examined the community within which the subjects (teachers) engaged in, the interactional nature of the social participation (between teacher -teacher; teacher-learner, and learner-learner), and the beliefs and values of the participants to understand how the collaborative nature of the activity system shaped teachers’ formative assessment practices. The community which I refer to comprise learners who work in groups, the school management team, the teachers and the parents. Each of these communities have their own roles determined by their own set of norms, and may have varied perspectives about the learning goals. I also examined how the division of labour shaped the collaborative relationship between the community and the object.

The main tools used to engage learners in collaborative learning were the AfL strategies, which were mediated by teachers in their enactment of formative assessment. As presented in chapter 4, teachers have the tools and techniques to promote collaboration, but that they do not embed them in their pedagogical practices. My observation is that although teachers acquired the skills (tools) during the professional development programmes, they did not internalise the logic of the process during the AfL training. It is my view that teachers focused narrowly on the AfL strategies and did not reflect on the purpose of the strategies for formative use.

One explanation could be that teachers tend to apply the strategies directly because their own history (Wertsch, 1993) of learning at school was through rote learning as discussed in chapter 2. Teachers think that by applying rote-learning techniques, they will become better teachers which is not true. In support of McCallum, Hargreaves and Gipps' (1997:65) claim that teachers do not merely deliver, they 'develop, define and interpret', I argue that teachers need to adapt and translate their learning according to the varied classroom contexts. This practice is consonant with Hayward, Priestley and Young's (2004) suggestions that it is primarily the responsibility of teachers to translate ideas and resources that are acquired in the teacher development workshops into classroom practice.

Another possible reason for the ineffective enactment of formative assessment is that teachers view formative assessment as the technical execution of the tools (AfL strategies) In this regard, Heritage (2010: 19) proposed a need to "redress the balance of formative assessment as an instrument towards formative assessment as a process for enabling learning by channeling the investment into teachers rather than tools". This implies that teacher development should focus more on developing teachers' knowledge and skills to help teachers enact formative assessment (Heritage & Niemi, 2006).

Another possible reason for the ineffective social interaction in the classroom could be explained through CHATS' attention to power relations. CHAT is useful in explaining how the "division of labour" component influences the "relationship between teachers and learners on formative assessment" (Crossouard, Pryor & Torrance 2004: 121). The notion of collaboration implies that formative assessment is a joint activity that requires all participants, namely; teachers, learners and peers to share responsibility for learning (Heritage, 2010). The sharing of responsibilities requires a shift in the nature of the classroom contract between teachers and learners. The role of the teacher is then to design and facilitate an effective learning environment that would provide opportunities for learners to take responsibility for learning within the environment. An enabling environment for formative assessment, allows for sharing of responsibilities, and promotes learners' engagement through peer and self-assessment as proposed by Heritage (2010). This requires a shift in the traditional power relationship where the teacher relinquishes some control over classroom interactions by sharing power with the learners. In this study, the hierarchical relationship between the teacher and the learner created a tension that inhibited collaboration in the classroom. In my view, the possible reason for teachers' difficulties in relinquishing control could be the result of accountability pressures imposed by the school management team.

This diminishes opportunities for sharing responsibility and prevented teachers and learners from achieving the desired goal, which was improving mathematics-learning outcomes. Another tension that prevents teachers and learners from achieving the desired learning outcome was the teacher-dominated classrooms, which emphasises the transmissive approach to teaching. An enabling classroom environment for formative assessment requires a change in teaching practices that guide and enable learning instead of chasing after the curriculum. The learning environment needs to be non-threatening so that learners feel safe to reveal their misconceptions during instructional dialogues in the presence of other learners (CHAT - objects and outcomes – as discussed in chapter 2). In one classroom, I observed that teachers embarrassed learners by asking learners to show their incorrect answers on the mini white board to the whole class.

The "rules" and norms of the classroom also inhibited learners' interaction of the classroom. The mismatch between formative assessment principles and learning traditions of the classroom hindered the implementation of formative assessment practices. For instance peer assessment requires learners to engage in verbal discussions such as talking aloud and also questioning the ideas of the peers. However, the presence of rules such as asking learners to raise hands to answer and “no talking” was another tension, which hindered formative assessment practices. Teacher- learner dialogues were limited when teachers asked learners to raise their hands to answer questions. Wiliam (2007) noted that in classrooms that had rules for learners to raise their hands if they knew the answer, actually discouraged learners from engaging in class. Another problem with such practice is that the teacher gets to hear only one learner’s thinking. According to Black and Wiliam (2009), classroom discourse should be reflective, thoughtful, focused to evoke understanding and conducted in such a way that all learners can think and express their ideas.

Another challenge that constrained learners’ engagement is the limited time given to learners to answer questions. In most cases, teachers answer their own questions. These inhibitors could be attributed to only a minority of learners participating. Teachers need to develop their skills in designing questions to challenge learners understanding, prompting them to justify and explain their understanding. The analysis of teachers’ questions revealed that most Grade 3 teachers asked questions which required learners to draw on their memory and to recall factual information. This finding is supported by previous studies which showed that opportunities for discussion, dialogues and communication were restricted because teachers asked questions which expected short answers, or recall of facts (Black & Wiliam, 2006; Pryor & Crossouard, 2008; Shepard, 2005). One explanation for teachers’ ineffective use of questions could be attributed to the lack of effective teacher training opportunities that focused on developing thinking skills among learners.

Through the lens of CHAT, teachers’ difficulties in operationalising the strategies into their pedagogical practice could be explained by considering the tensions between the subject-tool-object nodes of the activity theory. The tensions between the teachers (subjects), the role of the subject advisors (division of labour) and the departmental regulations may account for the subject advisors’ description of teachers as being maliciously compliant.

In my view, the subject advisors' views of learners need to be problematised. I therefore question whether subject advisors, in making such judgments really know the teachers all that well in order to support them. My experience of the hierarchical structures in the schooling environment and the strict enforcement of practice that requires teachers to follow policies and prescriptions without interrogating whether the context is conducive to learning say otherwise.

5.3.3. Theme 3: Teachers have some awareness of skills and strategies to find out if learners have learnt something

Although teachers are somewhat cognisant of the use of questioning, dialogues and AfL strategies to gain knowledge of how learners think mathematically, they somehow experienced these tools as being complex and difficult to operationalise into their formative assessment practice. Instead of using the information formatively to find out how learners are progressing towards the learning objectives, I would argue that most teachers used these strategies for evaluative purpose to find out what learners learnt, rather than help learners achieve the outcomes. Hence, it is for this reason that many of the learners' learning gaps often remain unresolved resulting in many of the mathematical outcomes being unattained.

Theme 3 is discussed under the following subheadings:

- The role of questions in assessing learners' learning
- Technical application of Assessment for Learning strategies

The role of questions in assessing learners' learning

Most teachers asked low ordered questions which precluded teachers from gaining deep insight into how learners think. The lower ordered questions assessed learners' "declarative (knowing what)" and "procedural (knowing how)' types of knowledge, and disregarded the "schematic (knowing why)' and "strategic (knowing why, when and how) knowledge acquisition (Liu, 2015:13). Very few questions focused on assessing learners' critical thinking, reasoning and application of knowledge. Most of these questions were insignificant to gauge learners' thinking and were therefore not productive for learning.
This finding is consistent with the meta analytical studies by Cotton (2000) which

highlighted the dominant use of "lower order" knowledge based questions focusing on recall of facts as discussed in section 2.4.1.

Teachers in the study rarely asked questions to direct learners' thinking through the task to solve problems which presents opportunities for formative assessment as stated by Wood, Cobb & Yackel (1991). Instead, teachers asked questions to check if learners understood what they had taught learners rather than trying to understand how learners think (Minstrell, Anderson & Li., 2011). Asking questions for the purpose of finding out what learners know is described as being "evaluative" and has little use for formative purpose (Davies & Walker, 2007). This finding is supported by Popham (2009) who argues that rather than using questions evaluatively to find out what learners know or do not know, teachers need to use the questions "interpretively" to gain insightful understanding about learners' thinking. The importance of partially correct or incorrect answers are highlighted by Popham (2009) as potential sources for formative assessment and should be acknowledged and used as a springboard to improve instruction.

Another finding is the mismatch between the questions and the learning outcomes. This problem was most prevalent when teachers used analogies or representations to explain a concept. The questions asked and the prompts used were irrelevant, as it had no resonance with the mathematical learning outcomes. This often resulted in inaccurate information about learners' understanding and caused teachers to rely on their assumptions about what learners were thinking. Inaccurate assumptions could lead the teacher to make unhelpful subsequent instructional decisions, which does not address the actual learning needs of learners. Teachers also found it difficult to respond "in the moment" to learners' ideas and to ask appropriate follow up questions to prompt learners. Similar findings were reported by Franke et al. (2009) that teachers readily ask initial questions to elicit learner's mathematical thinking, but struggle to probe learners to follow up on learners' ideas. Another finding was that the closed ended questions stifled learners' interaction, specifically learner talk. Learner talk is significant in understanding how learners' think and is an important affordance of formative assessment opportunities (Ruiz-Primo & Brookhart, 2017).

Learner talk can make it possible for the teacher to monitor learner's mathematical thinking, to use the information to inform their decision- making practices, and to pose and follow up question, which is a process of formative assessment. Providing explanations is positively related to the achievement of outcomes, in relation to giving answers (Webb & Vulliami, 2006). It is my view that teacher's inability to ask thought provoking and creative questions could be attributed to teachers' total dependency and reliance on prescribed lessons to the extent that teachers' creativity and innovations have become somewhat stifled.

In addition to the types of questions used, teachers' questioning techniques were another concern that constrained teachers' formative assessment practice. Teachers asked multiple questions all at once, often termed double-barreled questions, which often confused learners. Teachers also asked leading questions, which inhibited learners thinking. These questions are related to what Bauersfeld (1994) refers to as the "funneling effect". Further questions arise when a teacher sees something and tries to get learners to see it by a series of indirect, but increasingly directed questions. Another problem was insufficient wait time for learners to respond to questions. The problem of reduced wait time to allow learners to engage critically with the questions have been reported in studies by Askew (2012) and Walsh & Sattes (2016) as discussed in section 2.4.1.

The findings showed that the omission of stimulating questions in mathematics teaching is a possible tension that could account for the unattainable goals of learning. Given the need to include a variety of questions in teaching, it is imperative for the teacher to think deeply about the instructional goals and to plan the type of questions that would enable teachers to understand learners' thinking. This would require teachers to clarify the instructional objectives for a particular lesson, analyses the learner's ability level, then plan the type of questions appropriately. This view is supported by Ginsburg (2009:5) who emphasizes the need for teachers to conduct assessment that provides them with a practical 'theory' of the child's performance, thinking/ knowledge, learning potential and affect and motivation. With this in mind, I argue that an awareness of the cognitive processes of learners will enable teachers to select and design appropriate activities.

Tokenistic use of Assessment for Learning strategies

A key finding in the study is that teachers know about the AfL techniques (tools), but seldom use the techniques for formative purposes as presented in chapter 4. An analysis of teachers' use of white boards showed that teachers looked for wrong or correct answers, and were less interested in correcting learners' misconceptions and errors. I would describe their teaching as being product driven rather than process oriented. This finding resonates with the studies by Leatham, Peterson, Stockero and Van Zoest (2015) who identified teachers' difficulties in identifying and interpreting the evidence of thinking to build on learners' mathematical understanding. It is my contention that teachers do not have a full understanding of the purpose of these techniques, which could be attributed to poor preservice teacher training and inadequate district and school level support. This finding was confirmed by the subject advisors who stated that their monitoring has become a 'tick box exercise as they themselves are not mathematics specialist, yet they are expected to support the implementation of the AfL in mathematics.

Various tensions and contradictions emerged while interpreting this theme, which hindered teachers' implementation of formative assessment practices. Through the lens of CHAT, it can therefore be concluded that teachers have the tools (strategies) to find out what learners know or do not know. However, the ineffective use of the tools precluded teachers from understanding learners' thinking and therefore constrained teacher's formative assessment practices. Teachers asked more lower ordered questions that were not aligned to the developmental level of learners, which prevented teachers from understanding learners thinking, which is essential for formative assessment (Lee & Ginsburg, 2009).

Ruiz - Primo & Brookhart (2018: 7) who stated that low ordered questions "limits learners' thinking and opportunities to process content and to achieve the learning outcome" also supports this finding. Understanding learners' thinking is an important component of formative assessment and teachers should therefore keep learners' thinking in mind when defining the learning goals, selecting strategies to elicit information from learners, analysing and interpreting the data and responding to learner effectively to support learning (Ginsburg, 2009:3). Formative assessment "is a process of gaining information on learners learning to improve instruction and that formative assessment can be an organized, informal or spontaneous and just in time to ascertain the extent to which learners have achieved a learning outcome. (Ginsburg, 2009:3).

Through the lens of CHAT, I was able to understand the teacher (subject) and the teacher's dominant use of lower order questions in relation to higher order questions (Baird, Andrich, Hopfenbeck, & Stobart, 2017), I have concluded that there may be several reasons. Teachers have become technicist and tend to ask the type of questions that they were asked when they themselves were learners. It is my contention that teachers do not think about and reflect on the assessment questions and strategies that they use. I therefore concur with Schön (2017) on the use of reflection on action, reflection in action and reflection for action for improving practice of formative assessment. Reflection on action occur during the planning of the activities and requires the teacher to anticipate how learners may respond and to generate appropriate interventions and questions. Reflection related to formative assessment is a needed component in teaching. Although teachers think that they are assessing learners formatively, they do not recognise these activities as components of formative assessment, and therefore miss opportunities to maximize the formative impact of the activities. The tools used by teachers were ineffectively mediated which prevented learners (object) from attaining the outcomes which was improved learning of mathematics. Another reason for asking lower ordered questions emanated from the tensions arising from learner's lack of knowledge from previous years (division of labour). Teachers could not move beyond recall questions, as learners were not accustomed to providing lengthy answers that required reasoning. A possible reason could be that teachers focused on procedural ways of teaching that required procedural answers. However, in this study, the closed question types limited learners' dialogues, which could be provocative tool to stimulate learners' thinking and to take ownership of their learning.

The division of labour component could explain a plausible reason for limited learner talk in the classrooms. Most classrooms are teacher centred resulting in teachers asking the questions and learners answering. (Walsh & Sattes, 2016). With regard to the influence of the community, the study highlighted the social nature of formative assessment as being located within the wider socio cultural structures, which has a huge impact on the way it enacted. The social nature of the formative assessment implies a triadic relationship between the construction and execution of both teacher and learner identities. The different identity formations of teachers, parents and learners can be used to explore and account for the issues of power in formative assessment. The learners were viewed as a community of learners in which they used each other as resource. Teachers viewed parental involvement as a barrier to formative assessment practices as the primary concern of parents is summative assessment, which is used for grading learners. Teachers also mentioned that all that parents want to see is evidence of written tests and marks obtained for each written test. It therefore follows that teachers' formative practices are somewhat influenced by parental demands. The membership of the community that shapes formative assessment is therefore complex where each member (parents for example) demand their own expectations, which conflate teacher's rationale and motivation for formative assessment.

The object (subject) component of the activity system could be explained through the problematisation of "learner agency" which emerged as another finding. The learners (object) of the study were considered as subservient and were the receiver of knowledge. Classrooms were teacher dominated as learners seldom asked questions. Allowing learners to ask questions activates learners' cognitive processing activities and helps learners to regulate their learning process (Walsh & Sattes, 2016). Teacher dominated classrooms could be attributed to the hierarchical relationship between teacher and learner which inhibits collaboration in their learning. The power relations inherent in the classrooms revealed a traditional division of labour, which entailed that assessment, is done to the learner, rather than with the learner. The cognitive processes of learning are shaped by society and does not occur in isolation. Therefore, the classroom practices of teachers is dependent on the type of teacher and learner interaction that occurs during the daily classroom instruction. The teacher assumes multiple identities such as assessor, teacher, subject expert, and learner, which were being constantly reconstructed.

Learning mathematics is a shared responsibility between the learner and the teacher. The teacher has a pivotal role to play in constructing appropriate questions that would guide learners to construct their own learning. Within a constructivist-learning environment (Bruner, 1996; Copeland, 1984), learners are encouraged to adopt an enquiry-based approach to learning. This is not an easy shift for learners and the expectation that the teacher is still in “control” and the expert is still prevalent. Within the activity system, it plays out as a process of moving the power back into the hands of the learners, challenging them to think for themselves. It became evident during the classroom observation that power was unevenly distributed within the social space of the classroom. The teachers’ power in the classroom is maintained through the monolingualism, which attempts to stifle the interaction, the dialogue and the potential for learners to think critically.

The national and provincial departmental requirements for accountability (DoE, 2011c), which constitutes the “rules” of the activity system exerts a powerful influence on teachers’ formative assessment practices. The data showed that teachers are becoming increasingly disempowered as they become more and more dependent on the norms and standards set by the district, provincial and national education departments. Many teachers have resorted to teaching to the test and seem to ask questions that focus on correct answers. I also found that teachers’ rigid adherence to the lesson plans constrains teachers’ formative assessment practices as it does not take into account the diverse abilities of learners (DoE, 2011b). Teachers tend to teach following the prescribed lessons, yet these lessons often does not respond to the needs of the learners. When teachers use tasks and questions designed from the prescribed lessons, as was the case in this study, it precludes them from identifying and addresseing individual learning needs. It is my view that even if teachers are required to follow prescribed lessons, they should be able to develop “new” activities by perhaps borrowing and adapting old ideas, instead of using activities that does not meet the learning needs of students as proposed by Hodgen and Wiliam (2006). Tasks that are thoughtfully designed can yield rich data on learners’ thinking, can help teachers identify problems learners encounter and can help teachers plan the next steps accordingly (Hodgen & Wiliam, 2006).

It was also evident in the study that the rules of asking learners to raise their hands if they knew the answers appeared to stifle learners’ engagement in class. Instead of asking those learners who raised their hands to answer the questions, the teachers chose to ask learners who did not raise their hands which discouraged eager learners as they were less motivated, and disengaged in making their learning explicit. The alternate strategy to raising hands was the popsicle stick strategy explained in chapter 4. It was evident that both the teachers who used this strategy clearly showed a misunderstanding of the implementation. Instead of posing question to the whole class and then picking out a name, both teachers selected a name first and then asked the question, implying that it was directed to a particular learner. This practice resulted excluded the other learners from thinking about the questions as the questions were directed to only the learners whose names were selected.

5.3.4. Theme 4: Teacher's limitation and usability of formative assessment in improving learning

Teacher's idiosyncratic conceptions of formative assessment

As presented in chapter 4, teachers have an idiosyncratic conception of formative assessment which is evident in their multifaceted and interconnected conceptions of formative assessment. The two most dominant conceptions of formative assessment that emerged in the study is the accountability conception and the improvement in learning conception which explains teachers' classroom practices. This finding is supported by Elwood and Klenowski (2002) who found that the varied definitions and the consequent conceptual understandings of formative assessment resulted in confusion around what formative assessment implies in practice. In this study, teachers' implementation of AfL strategies appeared to be superficial which may be attributed to teachers' lack of understanding around the AfL principles. Interestingly, none of the teachers were able to explain formative assessment as a continuous process that involved a number of activities. Teachers were of the opinion that they were enacting formative assessment even if they implemented just one strategy. As explained in chapter 2, formative assessment is a process used by both teachers and learners during instruction to adjust ongoing learning to improve learners' achievement in the intended outcomes. A case in point is advanced by Black and Wiliam (1998:140) that "assessment becomes formative only when the evidence is actually used to adapt the teaching to meet learners' needs".

In this study, teachers mentioned strategies used to find out what learners learnt but they were not able to explain how they used the information to improve learning. Teachers' vague understanding of formative assessment has given rise to problems in the enactment of formative assessment in the classroom. This finding supports previous studies by Bell and Cowie (2017); Black and Wiliam (2009) and Stobart (2008) which showed that teachers' lack of understanding of the theoretical underpinnings of the strategies and its integration with pedagogy and learning was a major reason for the ineffective implementation.

Through the lens of CHAT, the tension between the dominant role of summative assessments and externally imposed accountability requirements and the improvement of learning conception provides a strong explanation for teachers' limited use of formative assessment. Both these conceptions of formative assessment interconnect with each other. Several scholars (Black 2015; Harlen, 2007; James, 2006) argue that summative assessments is used to assess the extent to which learners have mastered the curriculum while formative assessment focuses on the ongoing, developmental aspects of learning hence both types of assessment serve different purposes. In this study, it seemed that teachers experience a tension in reconciling the demands of summative assessment which holds teachers accountable with formative assessment. The finding is this study resonates with the claims advanced by James (2006) that teachers who tend to avoid taking risks in their implementation focus on goals that are unassessed. Hence, it became evident in the study that most of classroom assessment practices focused on improving learners' achievements in tests, rather than promoting learners' learning experiences. The implications is that teachers' teaching styles followed approaches that were not aligned to the principles of formative assessment but emphasised "transmission of knowledge, teaching to the test and narrowing of the curriculum" (Stobart, 2008: 87).

Moreover, the "rules" of the curriculum and the policy directive; as well as the "division of labour" specifically the role of the education department in monitoring curriculum coverage seemed to have an impact on teachers' enactment of formative assessment. The curriculum model, the prescribed lessons together with the ATPs constrained teachers' formative assessment practices. In part, teachers' experienced the ATPs as aggressive pacing guides that creates pressure for teachers to keep on track rather than to slow down and reteach when the need arises. Effective implementation of AfL requires time and flexibility so that teachers can adapt their lessons, use different strategies and "take risks in their practice" (Earl, 2012). In addition, teachers viewed the ATPs as too prescriptive as it did not take into account the individual differences of learners. Learners learning pace differs with some learners requiring multiple opportunities before they can grasp a concept, which could not be accommodated in the ATPs. I therefore argue that teachers' formative assessment practices were constrained as teachers adhered rigidly to the scripted lessons and ATPs without reflecting on what curriculum coverage means beyond. Teachers were of the misunderstanding that the curriculum coverage meant teaching everything what is in the plans, rather than teaching so that learners understood the content. This misunderstanding was evident in the way teachers completed the CCM reporting tool which showed that teachers reported on all what they had taught irrespective of whether learners have understood the content and viewed this as "curriculum coverage" To stay on track with the ATPS, teachers tend to be chasing after content coverage, resulting in surface learning with no time for formative assessment to identify and address learning needs.

Based on the finding of this study, I concur with Spillane, Reiser and Reimer, (2002) that teachers (the implementing agent) must be allowed the freedom and flexibility to implement the policy taking into account the prevailing context at the time. This means that curriculum policy even though prescribed must allow for flexibility when implementing it. In this way, central based curricula will not serve as a barrier for effective teaching and learning. Many teachers emphasised the role of summative assessment, the departmental pressures to complete the curriculum and accountability. Hence, I argue that the current issues related to formative assessment may be attributed to several factors including the diverse interpretations of what constitutes formative assessment (as was highlighted in section 2.2. in chapter 2), the pressures to complete the curriculum and the overemphasis on summative assessment. In this regard, rule (CHAT) compromises the teacher's response to effectively enact formative assessment in the classroom. In addition, formative assessment is difficult to achieve because the shift in teacher practice required is large and may involve changing teacher beliefs.

Teachers' beliefs on how learners learn shape their instructional practices

Another finding is that teachers' beliefs played an important role in their enactment of formative assessment. This finding was supported in studies by Aschbacher and Alonzo (2004) as discussed in section 2.9.3. Teachers who held constructivist views of learning as discussed in section 2.7.3 mentioned the use of learner- centred strategies. However these teachers' classroom practice was dominated by teacher directed activities. Similar findings were reported in studies by Roussouw, Rhodes, and Christiansen (1998) who observed that many teachers in the Western Cape believed in constructivist ways of learning but classroom practice showed that these teachers engaged in transmissive ways of teaching which left them no room for the inclusion of formative assessment.

In this study, teachers mentioned innovative strategies on learner centredness which showed that they understood what it meant in theory, but they did not seem to have the same understanding of what it means in practice, as it was often not reflected in their classroom teaching. Instead of allowing learners to make mistakes through self-discovery, most teachers emphasised correct answers and therefore used traditional teacher dominated approaches, which included teaching and explaining, giving answers to questions and asking learners to complete written activities. Skinner (1965) who postulated that teachers who followed the behaviourist approach to teaching argued that such approach limits teachers' opportunities for formative assessment. To illustrate this observation made by Skinner (1965), Sam embarrassed learners who gave incorrect answers by asking learners to stand up or to go to the front of the class to show their incorrect answers to the others. This somehow belittled the learner and eroded their self-esteem. This practice was contrary to Sam' belief expressed in the interview when she stated that learning is not about getting the correct answer. Instead the lesson observation showed that Sam focused on correct answers as she asked another child to give the correct answer. Instead of considering errors and misconceptions as opportunities for formative assessment, Sam disregarded and overlooked errors and misconceptions and limited opportunities for formative assessment practices. These findings are also supported by Morar's (2000) observation that, despite South African teachers' beliefs about learner-centred teaching approaches, they use traditional teacher directed approaches in their classrooms. I concur with the arguments by Valli and Beuse (2007) that "school and district based accountability pressures, such as curriculum coverage and systemic external assessments push teachers towards instructional practices that are less focused on mathematics and more focused on skill based teaching and coverage of content. Stols, Ono, and Rogan (2015) argue that the idea of learner centredness comes from policy documents and officials from education departments advocating this approach, rather than from teachers' own beliefs. This contradiction may provide an explanation for the gap between teachers' verbalised beliefs about learner centredness and their classroom practices. I argue that learner centred teaching approach on its own is not enough for effective teaching. It requires other related activities such as formative assessment to bring about improvement in the desired outcome.

Another problem was the limited time teachers afforded to learners to think about the questions they posed. Since teachers asked questions on what was taught, they expected learners to produce answers instantly from what they memorized which diminished learners' autonomy in learning. This finding is supported by Spillane (2000) who argues that teachers who are rooted in behaviorism at the expense of cognitivism may well compromise epistemological and pedagogical innovation in the classroom. Hence, teacher's ability to transform learner's belief systems in acquiring new knowledge will become rather difficult. The sentiment echoed by Spillane (2000) is exactly what I observed where teachers pedagogical and epistemological knowledge compromised their ability to implement and enact formative assessment practices effectively.

Teachers' variation in the type and quality of feedback

The study showed that teachers' understanding of feedback accounted for the varied practices of formative assessment. An analysis of teachers' interview responses about feedback showed that Bela and Sam had a vague understanding about what constitutes feedback while Sue and Elrie showed are aware that effective feedback brings about improvement in learning. For Bela and Sam, feedback is about giving children the correct answers, while Elrie and Sue viewed feedback as focusing on the process of learning. Interestingly, the interview responses of both Bela and Sam seemed to confirm the findings of the lesson observations as both these teachers often asked other learners to provide correct answers to learners who encountered errors or misconceptions instead of guiding and supporting learners to overcome the errors. Another finding was that feedback was most effective when it was directed at individual learners, rather than at the whole class. The finding is in keeping with Hattie & Timperely's (2007) meta analytical study, which showed that feedback was the most powerful modifier that enhanced learner achievement.

The analysis of learners' written work showed that teachers' feedback lacked detail and constructive comments. This finding resonates with Lee's (2009) observation that teachers experienced feedback as one of the most difficult areas in formative assessment and teaching in general. To illustrate Lee's (2012) argument, I also observed the following practices: Teachers tend to write the correct answers in the learners' written books; where comments are written, learners do not respond to the teachers' written comments, and learners are asked to complete similar examples of tasks learners did not understand. Asking learners to complete similar tasks without providing feedback to address the error or misconception is of no value, as learners tend to represent to the teacher the same evidence of understanding without making much progress. A possible reason for learners not responding to feedback could be that learners do not even understand them. This finding is supported by Perrenoud (1998) who argues that feedback is useless if it is not readily intelligible to the learner, if it does not help the learner to understand, remember and improve her knowledge or extend her learning strategies. For feedback to have a formative purpose, it must help learners to identify the gaps in their learning against learning objectives and assessment criteria and indicate next steps to fill the gaps in their learning (Lee, 2009; Heritage, 2010). Moreover, it should focus on the quality of learners' work not on the self. Black & Wiliam (2009:5) stated that "feedback to any pupil should be about the particular qualities of his or her work, with advice on what he or she can do to improve, and should avoid comparisons with other pupils". Feedback is only formative if it has the potential to influence learner's learning and if it can help the learner to reach higher levels of understanding relative to where they were when the information was collected. (McCallum et al., 2000; Sadler, 1989) cited by Ruiz- Primo & Brookhart (2018).

Teachers also used stickers to praise or reward learners. Torrance & Pryor (1998: 40) argue, "Many teachers focus on praise as a form of 'feedback' because of the efficacy of behaviorist reinforcement systems". The most common type of feedback used was evaluative comments such as "good well done. Sometimes, motivational comments such, as "I am proud of you. You're a super star". Evaluative feedback does not discuss the problem or question, but it is more of a judgement of the learner or their work. The following are examples of teachers responses during the interview session on the type of feedback they provide to learners, namely a) scoring learners work and assigning marks out of the total, b) displaying the correct answer to help learners to get the right answer to questions they got wrong, c) inform their achievement against other learners, doing questions that learners' assumed difficult for them, and offering praise to learners who score high in the assessment task. However, feedback which focuses on praise, reward, criticism and that lacked guidance has low impact on learning (Bruno & Santos, 2010). Feedback in the form of marks and Grades have little value on learning (Black & Wiliam, 2001; Heritage, 2010; Stobart, 2008) because such type of feedback does not provide direction for next steps in learning (Kvale, 2007; Stobart, 2008; Black & Wiliam, 2018). Rather, it creates competitive classroom environment which undermine the self-esteem, confidence, and motivation of low achieving learners to improve their learning in future (Lee, 2009).

None of the teachers mentioned the use of learners' errors in formative assessment. Hence there was no evidence of the formative use of feedback in learners' written work as most of the feedback was evaluative, focused on correct answers, instead of improving learning. This observation is in keeping with the sentiments echoed by Lee (2009) with regard to feedback. Lee (2009) found that while teachers focused on errors in learner's tasks, they rarely focused on how learner' errors could be used to improve understanding.

It became evident in this study that feedback was most effective when it was directed on the process of learning than on correct answers. The finding that feedback directed at the process of learning is consistent with the results of previous studies by Harks, Rakoczy, Hattie, Besser and Klieme (2014) indicating that process oriented feedback had a greater positive indirect effect than Grade oriented feedback on learners' mathematics achievement. In their studies, Harks et al. (2014) found that feedback that was directed at the process of learning was elaborate and therefore was more useful to learners. Although both Sue and Elrie, showed some understanding of the term "feedback" that its purpose is to contribute to improvement in learning, there was no evidence from the learners written work to substantiate the claim that they could apply feedback to improve learning. The analysis of the learners' workbook showed that teachers had not given any constructive feedback. Neither could the participants demonstrate their knowledge of feedback during the lesson observations. It is my observation that teachers found it difficult to interpret the evidence of learning against the learning objectives and therefore aligning feedback to the learning objectives was not an easy task for teachers. It seemed that most teachers often judged learners' performance in relation to other learners, rather than against the learning outcomes. Once again, this finding supports Torrance and Pryor (1998: 40) who argue that teachers place emphasis on learner mistakes in their feedback rather than providing feedback on how these mistakes can be corrected either procedurally or conceptually.

In some cases, the feedback lacked specificity and mismatched the learning outcomes. A case in point was explained in Bela's feedback to learners who confused the values of the digits in 15 and 51. Despite the feedback, learners still could not compare 2 digit numbers with the same digits in reverse order, for example 15 and 51. It is my contention that the mismatch of feedback to the learning goal is attributed to teachers' limited mathematics content knowledge, which precludes teachers from providing scaffold support appropriate to the learning goal. The use of specific and detailed feedback as learning occurs is essential in a subject like mathematics, which is hierarchical in nature and requires learners to master basic concepts as foundational to complex concepts.

According to Hattie (2012) simply telling a learner to 'try again' or 'reconsider your work' does not possess the qualities of formative feedback because it does not strategically guide (or scaffold) learning by telling the learner how or why they need to do this. Feedback should therefore focus on task performance, understanding processes or regulatory processes. A possible reason cited by Ruiz- Primo and Brookhart (2018) on the effective use of feedback is that teachers have limited knowledge of formative assessment practices and therefore tend to limit their collection of evidence to the correctness of learners' work. In this study, teachers who emphasised the correct answer did not focus on finding out the learners' current state of understanding. The role of teacher feedback is to help learners move from the current state of understanding to the next step towards mastery of a learning goal (Ruiz-Primo & Brookhart , 2018) .

5.3.5. Theme 5: Teachers have limited conceptual knowledge of mathematics and how to communicate them clearly and coherently in instruction

Another finding that emerged strongly is teachers' limited conceptual knowledge of mathematics which inhibited their formative assessment practices.

This theme will be discussed under the following two sub themes:

- Teachers' limited conceptual understanding of mathematics
- Teachers' haphazard and non-coherent use of analogical reasoning in explaining concepts to learners

Teachers' limited conceptual understanding of mathematics

A key finding was teachers' limited conceptual understanding of mathematics which resulted in teachers' almost exclusive reliance on procedural (tools) ways of teaching. The problems associated with teachers' dominant use of procedural ways of teaching and how it precludes learners from developing conceptual understanding is discussed in section 2.5.2. drawing on relevant empirical studies. The study showed that even the feedback which teachers provided to learners to correct learners' calculations reflected attempts to correct incorrect procedures rather than develop conceptual understanding. It was also observed in many classrooms that learners were able to get correct answers through procedures, yet they lacked conceptual understanding.

Similar findings were reported in studies by Venkat and Naidoo (2012) that learners who were exposed to procedural ways of teaching across the schooling sector were able to perform successfully on routine paper and pencil problems but appeared to lack essential underlying conceptual knowledge. Stigler and Hiebert (2009: 20) argue that the exclusive reliance of procedural knowledge mediation can have "deleterious consequence for learning". In this study, it was evident that many teachers mediated the rules and the procedures without establishing and promoting relationships and linkages to conceptual knowledge they are supposed to represent. For example, in one of the assessment episodes observed in Elrie's lesson, Elrie emphasized the positioning of the 3 digit numbers to teach vertical subtraction with borrowing. It was clear that the procedures used to teach the concept confused learners as learners viewed the rules and the positioning of digits as two separate, independent events. Although Elrie taught the learners' vertical subtraction with two digit numbers the previous week, the learners were not able to transfer that knowledge from two digit numbers to 3 digit calculations. A possible reason for learners' inability to transfer their prior learning to new situations could be explained by Stigler and Hiebert's (2009) claim that procedures are taught separately from conceptual knowledge.

Through the lens of CHAT and the interconnections of the activities within the system, I noted that teachers' limited conceptual knowledge of mathematics served as a barrier if not hindrance to their enactment of formative assessment practices. Seemingly, it dawned upon me that the Activity theory was a good choice for exploring teachers' instructional practices as this data analytical framework allowed me to examine how the activities of teaching and assessing mathematics and how the interaction between these activities shape, enable or inhibit the formative assessment practices of teachers. In this study, the exclusive reliance of procedural strategies *(tools)* employed by teachers in teaching place value restricted classroom opportunities for formative assessment. Formative assessment requires teachers to continually assess learners learning and to respond to learner's needs as they occur. Teachers' limited conceptual understanding, poses a challenge for teachers to take decisions "in the moment" to help learners.

Furthermore, teachers in the study seldom used manipulatives in developing conceptual understanding amongst learners, yet the use of manipulatives are regarded as essential for deep conceptual understanding of mathematics in the early grades as discussed in section 2.5.2. As explained in chapter 2, effective teaching of mathematics, particularly place value requires more than the mechanical application of procedures and rules. It requires the effective use of manipulatives to help learners connect ideas and integrate their knowledge in order to gain a deep understanding of mathematical concepts. I concur with Roussouw (2010) who argues for the use of base ten blocks for the conceptual development of place value, particularly to show the concepts of regrouping and how to trade in a ten bar for ten ones. Together with the use of manipulatives, the teacher could structure learner talk and interaction that requires reflection to promote the conceptual development of place value, which could in turn promote opportunities for formative assessment. I argue that teachers' lack of conceptual and logical understanding of place value may be a possible reason why teachers do not use manipulatives effectively in teaching mathematical concepts. This may be a possible reason why teachers cannot teach and assess learners' understanding of mathematical concepts accurately. I would argue that engaging learners in practical demonstrations using manipulatives presents opportunities for formative assessment as it makes learners' thinking visible.

Another possible reason that seem to inhibit teachers' teaching for conceptual understanding may be attributed to the tension between the National curriculum policy requirements and the accountability pressures experienced by teachers to cover the curriculum. The National curriculum is seen as the mediating tool (end all and be all) that guides the teaching of mathematics. However, many teachers seldom follow the guidelines of the curriculum policy. Instead, teachers tend to focus on the curriculum knowledge mainly on the achievement objectives of mathematics because of accountability pressures. Teachers focus on covering the curriculum stifled their innovativeness in their teaching practices.

Teachers' haphazard use of analogical reasoning in communicating mathematics ideas to learners

Another important finding in the study was that some teachers tend to use analogies to link learners' prior knowledge to the new knowledge as they attempt to make the unfamiliar mathematics concepts familiar to learners. In many instances, the analogies were ineffectively used in communicating conceptual understanding of mathematical concepts to learners. In one of the assessment episodes in Bela's lesson, she used the analogy of a house on fire to teach the concept of "rounding off". Bela asked the following question: "*If house number four is on fire, where will you run for help? Will you go to house number zero or house number ten?*" It was assumed that learners would say that they would go to house number zero, as it was closer. However, only a few learners said that they would go to house number zero because it was closer. The other learners were able to see different solutions to the problems and presented different logical answers. For example, some learners disagreed about going to house number zero stating that the fire would spread quicker to house number zero being closer, hence they would run to the house that is further away. This was an example of cognitive conflict. Interestingly, learners with gave the answer which was correct for the analogy but incorrect for rounding off given that four rounded off to nearest ten is zero. High ability learners responded that they will "not run" to house number zero because the fire will spread quicker to house number zero than house number ten. In this study, the more capable learners engaged in deep thinking and provided responses that were logical although it was not directly related to the concept of rounding off. Studies conducted by Sutala and Krajik (1988) showed similar findings where learners with high cognitive abilities benefited from creating their own analogical connections, whereas learners with low abilities benefitted more from having the teacher help them make the analogical connections. It can therefore be concluded that the levels of complexity of the analogies must therefore match the capabilities of the learners.

Those learners who could relate to the analogy participated actively in the discussions, while learners who could not identify with the analogy, alienated themselves from the discussions. Failure to engage in the lessons, limited the teachers' opportunities to understand what learners know, which in my view, is an important strategy for formative assessment. This example also illustrates the mismatch between the house on fire analogy and the outcome, which is rounding off. The house on fire had different structural features to that as numbers and was therefore an inappropriate example. The mismatch between the analogue and the target can cause learners to transfer their understanding of running to the number furthest from number four, i.e. number ten, to rounding off which will then become a misconception that four rounded to nearest ten, is ten instead of zero. In another example, Bela used the analogy of a family to explain the position and value of the numbers in a three-digit number. Bela drew a picture of a house with 3 columns to represent the different rooms the family occupied. She explained that each family member lived in separate rooms. Similarly, the numbers also "lived in separate rooms". The teacher illustrated this by writing each digit in separate columns. She further explained that like the family members, numbers could not live together as they constantly fought. She does a double, almost triple layer of analogical reasoning, which is abstract by personifying numbers, which is about quantity, as compared to living in a house.

I therefore concluded that teachers' used analogies in a haphazard manner, partly because of their limited conceptual understanding. Teachers are aware of the importance of linking new knowledge to something familiar to learners but they do not to have a repertoire of relevant analogies that is appropriate to a mathematical concept. Even the type of questions teachers asked showed that teachers held traditional views of the learning process, which was based on the transmissive approach. Accordingly, the analogies were not based on social constructivist approaches (as discussed in chapter 2 – learning theories; Vygotsky's Zone of proximal Development) to allow for opportunities for learners to demonstrate their conceptual understanding.

5.3.6. Theme 6: Professional aspects of being a teacher are valued

A discussion of theme six is presented under the following three sub- themes:

- Teachers value teacher agency in their pedagogical practice
- Teachers value on going continuous professional development
- Teachers' value learning from professional learning communities

Teachers value teacher agency in their pedagogical practice

Another finding which emerged strongly in the study is the importance of teacher agency in the enactment of formative assessment. In section 2.9.1, I drew attention to the role of teacher agency in teachers' formative assessment practices. The teacher participants expressed concern that the scripted lessons and the curriculum coverage model which prescribed the pacing of their teaching eroded their sense of agency to make unfettered and independent choices, to engage in autonomous actions, and to exercise judgment in the interest of others and oneself. The prescriptions also made it difficult to take into account the learner profile and the school context within which they teach. This finding is consistent with the claims advanced by Priestley et al., (2012) that there is ongoing tension within educational policy worldwide that seek to reduce the opportunities for teachers to exert judgement and control over their own work (teaching), and those who (school districts and provincial department of education) seek to promote it.

This finding is supported by Sloane (2006) who argued that prescriptions place undue burden on teachers, and by Lasky (2005) who posits that teachers feel a sense of vulnerability in order to achieve outcomes and objectives of "politicians" (national and provincial education decision makers) who have little regard, or respect for contextual factors of each school. The points highlighted by the authors above, have reference to the findings in this study i.e. teachers have difficulty in following the prescriptions of scripted lessons. In this regard, for example, teachers mentioned that they were not able to follow the pace of the lesson plans, because their learners were so diverse. Some teachers admitted that when the scripted lessons were offered to them, they followed them religiously as they were presented, and went on to progress to the next lesson even though learners had not grasped the concepts taught previously. The teachers also stated that the lesson plans did not make provision for consolidation or revision of the previous work (recognition of prior learning/ learning progression). These experiences of teachers emerged as a tension in the activity of the classroom as it worked against the principles of formative assessment.

Halliday 1998) provide an added view which says, “If teachers are required to teach according to what has been planned for them, this may be thought to cast them in the role of mere technicians”. I would argue that the teachers’ rigid adherence to the prescriptions could be attributed to their preoccupation of accountability to the education authorities rather than what is in the best interest of learners’ progression. Rather than maintaining their individuality and autonomy, teachers have become agents of socialization as well as change agents, whose choices and actions reflect the implementation, interpretation, adaptation, alteration, substitution, subversion, and creation of curriculum context in which they work.

Teachers also felt that their trust as a professional being was being undermined, as they had to report to the educational authorities on a termly basis. In keeping with this finding from my study, Sloane (2006), too noted that teachers were not in favour of a recipe driven approach to mediate teaching and learning. Added to this finding, I surmised that some teachers felt that the scripted lesson plans were too prescriptive and did not allow teachers any room for flexibility which is basic principle of formative assessment. Furthermore, the finding showed that teachers felt an urge for flexibility in order to contextualise teaching and learning, taking into account the learner and school profile within which they teach.

In my view, it raises some critical issues about the way in which teachers who follow scripted lessons engage with the curricular policies and their agency. I argue that part of the problem can be attributed to teachers’ superficial understandings of the use of scripted lessons. This finding is supported in studies by Priestly et al., (2012:32) which showed that many of the teachers’ classroom practice “appear to be a combination of competing and vague ideas, personalisation, choice, learning and, in the absence of opportunities for systematic sense-making in schools" leaving teachers confused about their role. Most teachers viewed teaching as being driven by the externally imposed goals of the ATPs, which prescribes the pacing of the curriculum. My thesis is that such goals are short term in nature as they focus primarily on the progress based on standardised requirement at the expense of focusing on long-term significance and impact for deep conceptual learning. It is no doubt that ticking the right box to show that the work is done does not equate to curriculum coverage, unless learners have understood and mastered the content and skills to a reasonable level. Instead of using the CCM reporting template to report on what learners had learnt, teachers reported on what they had covered in the ATPs. Hence, curriculum coverage is about what learners learn and not only about what teachers teach. I would argue that the lack of mediation of the CCM and departmental guidelines to teachers may be a possible reason for teachers' misinterpretation of the intentions and purpose of the CCM model.

Teachers value professional development opportunities

The study showed that teachers need on-going support from school management and district in implementing formative assessment practices. In section 1.10.1, I discussed the importance of effective school - based leadership in promoting formative assessment. The role of the different levels of support (school, district and provincial) is explained through an interpretation of the division of labour element of the activity system of the school. This study showed that there is little synergy, regarding the implementation of the AfL, between the school, district and provincial level, resulting in variation of implementation from school to school and from teacher to teacher. In most schools, the SMT were apathetic towards the AfL programme. Their sporadic support (according to some of the teachers) for the implementation of the AfL is attributed, in part, to their lack of understanding of the intentions of the AfL, as well as, their misunderstanding of the implementation of the programme. The SMT members were themselves not subject to any kind of advocacy or formal training (i.e. workshops) regarding the implementation of the AfL. Barber and Fullen (2005) argue that the tri-level system which includes all levels of the education system serves as gatekeepers for each other and in this way a strong monitoring and evaluation strategies could be developed.

The findings of this study also singled out the importance that teachers accorded to the role and frequency of effective communication between the tri-level partners, namely; between teachers, the school, district and province. Some teachers felt that the communication between these three levels is ineffective regarding the AfL and its implementation. Many teachers noted that there was very little support and communication from the District Office. They stated that they were not sure as to whether they were implementing AfL the way it was intended to be implemented, and hence welcomed feedback from the District. This view is in accordance with McLaughlin (1991) who argued that in order to ensure a sound understanding of the objectives and goals of the programme, both communication and coordination needs to be in sync, to ensure successful policy implementation.

Barber and Fullen (2005) also argue that those implementing the policy have to possess the same information base and have to interpret it in the same way as those who have formulated the policy; hence effective, timely, unambiguous communication should be the order of the day. The study also showed that the professional development workshops offered by the district focused on the mathematics content of what and how to teach but lacked focus on strategies on how to assess. Interestingly, the teachers were pleased that the professional development workshops in mathematics focus on both what and how to teach. Despite the inclusion of pedagogical content knowledge in the workshops, teachers felt that the mathematics workshops did not adequately equip them with skills, knowledge and strategies to address the complexities of the classroom demands. It became evident in the study that assessment was not integrated in the mathematics workshops but was presented in separate workshops. This was contrary to the key principle of assessing while teaching, which in turn will enable teachers to learn about learner's achievement and adapt their instruction accordingly to meet the needs of learners (Stiggens, 2002).

The findings also showed that in most cases the assessment workshops attended by teachers primarily focused on administrative issues around summative assessment. Biasness towards summative assessment in workshops may have contributed to teacher's difficulties and vulnerabilities in enacting formative assessment teaching learners with diverse abilities. The failure to integrate formative assessment in teacher education training and development programmes may have resulted in teachers learning how to teach without learning how to assess (Heritage, 2007)

Teachers also expressed a need for professional development workshops to help them assess and support learners with diverse abilities in diverse contexts. In section 2.10.3, I argued the importance of professional development initiatives in developing the capacities of teachers to adapt their activities to meet to local context and needs of learners. It emerged from the study that most of the workshops conducted did not consider the needs analyses of teachers, hence the workshops attended rarely addressed particular competencies and skills teachers needed in so far as formative assessment is concerned. Although teachers valued the professional development opportunities offered by the district, the teachers from the priority schools expressed frustration at being involved in too many intervention programmes simultaneously. This increased their workload as teachers had to implement different strategies simultaneously which often confused them. In addition, the different intervention programmes lacked coherence, which made it more difficult for teachers to implement. In section 2.10.3, I highlighted the importance coherence in the professional development initiatives.

In this section I drew on factors such as time, the idea of connecting professional development to teachers' existing practices and the need for professional development in formative assessment to be intensive and ongoing. A coherent professional development programme is one that builds upon what already exists in the school in terms of previous professional development, teacher's strengths and weaknesses and the curriculum.

In this study, teachers from the priority schools were involved in the Gauteng Provincial Literacy and Numeracy Programme and were compelled to teach the GPLMS lesson plans. Their teaching was being tracked by completing the curriculum coverage monitoring tools. Teachers were more concerned about completing the curriculum to show that it was done. While they saw the potential benefits of AfL, they could not implement the strategies, as it was time consuming and require additional planning. The rigid pacing of the content denied teachers the flexibility or time to integrate formative assessment interactions or AfL strategies within the GPLMS programme.

Studies have shown that for changes in practice to happen, it must be integrated into the teachers' existing routines (Schneider & Randel, 2010). If the AfL programme were integrated into GPLMS programme, which is an existing programme for school, then implementation would have been easier. Hence if teachers were given leeway to plan according to the needs of their learners, then implementation of AfL would have been successful. Coherent professional development also dovetails with what is happening at the district level in terms of initiative, goals and policies. Garet et al. (2011) found that coherence had a positive, indirect effect on teacher practices through changes in teacher's knowledge and skills and a direct effect on changes in teachers practice.

Teachers value learning in professional learning communities

Another significant finding that emerged in the study is the importance of professional learning communities (PLCs) in improving teachers' formative assessment practices. The value of PLCs was discussed in section 2.10.2 which highlighted how the PLCs brought together varying levels of expertise related to formative assessment. Although teachers acquired new understanding and knowledge about formative assessment at the AfL workshops, they seemed to struggle to integrate these strategies in mathematics teaching. A possible reason for teachers' difficulties may be attributed to the fact that the workshops were not focused on mathematics content but was generic. The importance of content focused workshops was discussed in section 2.10.3.

Teachers' formative assessment practices improved through their participation in the professional learning communities (PLCs) as they shared their understandings of the AfL techniques. These findings resonate with studies by Marshall and Drummond (2006) which reported on the positive outcomes of teachers' involvement in professional learning communities (PLCs). Prior to teachers' involvement in PLCs, Marshall and Drummond (2006) observed that the majority of lessons captured only the "procedures" or the 'letter' of AfL and only a fifth of the lessons captured the "spirit" of assessment. Teachers who adhere to the letter of AfL tend to rigidly apply the techniques whereas teachers who focus on the spirit tend to focus on the enhancing learning through learner autonomy. Although teachers in the study claimed that their understanding of the AfL improved, I observed (lesson observation) that teachers still struggled to internalise and operationalise these techniques into classroom practice. To my surprise, teachers in the study were teaching the children the meta-knowledge about formative assessment, which they acquired at the workshop. Wiliam (2011) is also of the view that high quality direct instruction workshops are only appropriate for increasing teachers' knowledge, but to change teachers' "deep ingrained, routinised practices", demands a different type of professional development such as "teacher learning based communities".

In this study, teachers learnt through collaboration as they collaborated with teachers from within their own schools as well as from neighbouring schools to discuss and share ideas about their practice. Similarly, studies by Parsad, Lewis, Farris and Westat (2001) found that teachers participating in professional development linked to school activities are more likely to improve their teaching. In this study, those teachers who participated in the PLCs worked towards integrating AfL strategies into the GPLMS which was an existing programme implemented by all the foundation phase teachers at the school. Given the fact that some learners in Grade 3 are functioning at lower grade levels, it is crucial for teachers to collaborate with other teachers across grades and within the phase to support one another for the purpose of formative assessment.

Having analysed the three sub themes under theme 6, the following tensions and contradictions have emerged through the lens of chat. The rules in the form of ATPs and CCM serve as an impediment to teacher's quest for accountability, responsiveness, flexibility and innovation to implement formative assessment in the classroom. It is clear that while district officials view ATPs and the CCM as an assistive strategy for foundation phase teachers, foundation phase teachers in turn view these two regulators (rules) as highly negative, obtrusive and retards their innovation and flexibility to contextualize their formative assessment practices.While teachers appreciate training interventions and workshops offered to them to improve their formative assessment practices (tools), teachers experienced contradictions and tensions in terms of the timing of these training interventions as it often clashed with their core work schedules.

Teachers felt that the training interventions should be synchronised to their availability considering their work schedules within the school.

Contradictions also emerged from the teacher's perceptions that the training interventions and workshops focused more on technical issues (administration and procedural issues) rather than conceptual strategies on how to promote enactment of formative assessment. This contradiction is aptly summarised by Garet, Porter, Desimone, Birman and Yoon (2001) Engeström (2001) who stated that professional development emphasizing subject matter content and how learners learn that content has the most impact on teacher learning, as compared to professional development on administrative, procedural and technical issues.

Another tension that arose through the CHAT analysis for this theme, relates to community. Teacher development programmes is not systemic where all stakeholders (teachers, HoDs, district officials) share development opportunities. Hence, there is a disconnection between outcomes and objectives of the training interventions. The district official included in this study specifically highlighted this tension. She stated that she had last taught 15 years ago and one cannot expect her to now go into the classroom and offer best practice in formative assessment to teachers and HoDs. My assumption is therefore that district officials are also in need of training interventions in order for them to support teachers and HoDs seamlessly. This finding is supported by scholars such as Moss et al. (2012); Stiggens (2010) and Heritage (2007) who argue for a shared understanding regarding formative assessment reforms as was highlighted in chapter 2 of this thesis.

The tension and contradiction that emanated from the "division of labour" relates to the criteria used to select teachers to attend training interventions. The idea or model for selection is for these teachers to return to school and cascade the training they received. All teachers included in this study were of the opinion that those teachers who received the training were in fact ineffective in workshops conducted to their peers upon their return from these training interventions. This give rise to the tension that those teachers who attended the original training intervention in formative assessment are in a far better off position than those peers who did not. Thus, formative assessment practices were highly differential amongst teachers in the same Grade. Similarly, Ono and Ferreira (2010) observed that the "cascade" model of professional development, was ineffective as it did not take into consideration the local contexts of teachers.

5.4. THE PATTERN OF THE MAIN FINDING

Based on the results of the analysis of the six themes as discussed above, I came up with the final findings into which the six themes would "fit" as if in a conceptual pattern (Figure 5.2).

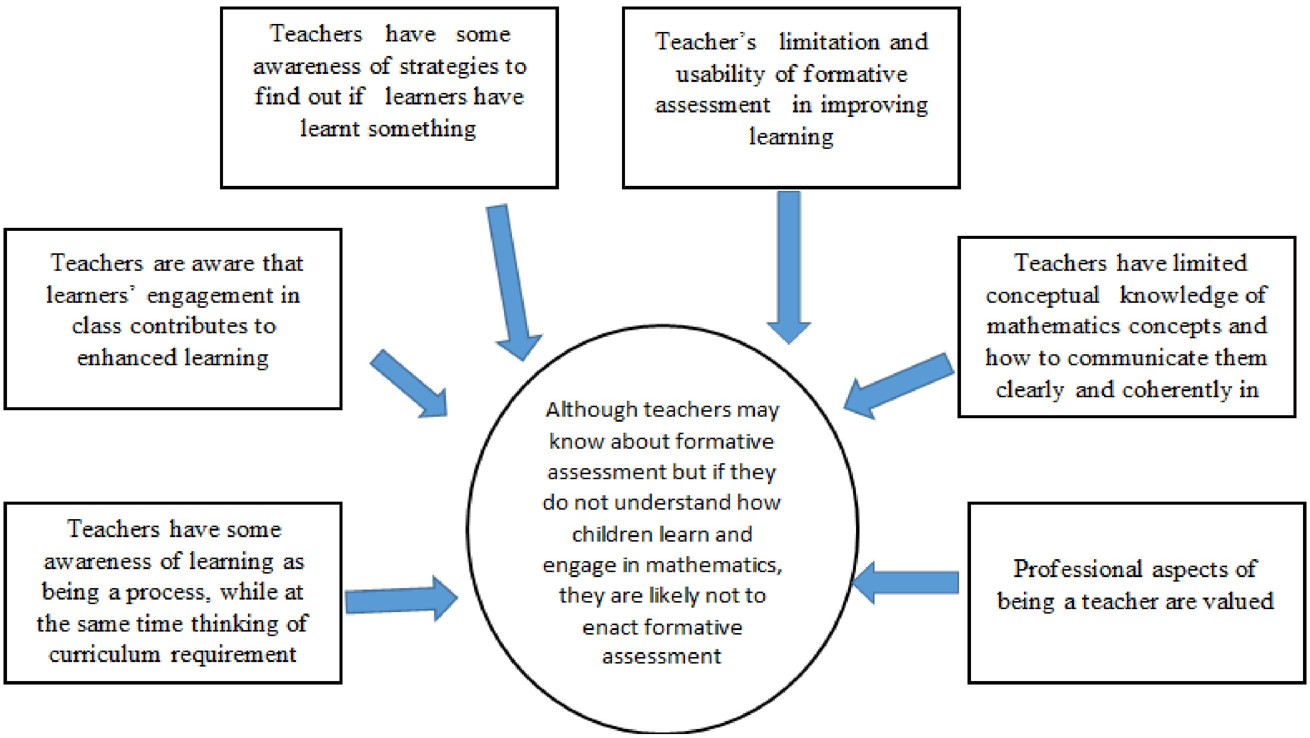


Figure 5.2: Pattern of the main finding

The central claim of this study is that, *although teachers may know about formative assessment, but if they do not understand how children learn and engage in mathematics learning, they are unlikely to enact it*. I therefore argue that while teachers who attend professional development workshops are able to use some of the strategies as singular tools, they remain unable to implement the combined strategies as an effective pedagogical tool that may exemplify formative pedagogy, or formative assessment pedagogy. Hence, the formative assessment practices of teachers bore limited possible returns on investment to improve learning outcomes in mathematics.

In the final analyses, I observed that even though some teachers attended professional development interventions, their classroom practices in enacting formative assessment was not authentic, but contrived.

5.5. THEORETICAL AND EMPIRICAL IMPLICATIONS OF THE PRESENT STUDY

A significant contribution of this study is its implication for theory and research with the use of CHAT as a heuristic for the interpretation of the data. Activity theory (in its third generation as CHAT) offers a lens for exploring teachers' formative assessment practices in mathematics teaching. The study was concluded with the claim that the different components of the activity system of the formative assessment classroom have the potential of influencing the outcomes of mathematics pedagogy. In the analytic mechanism of activity systems analysis (ASA), as propounded by Engeström (1987, 2015), the outcome of an activity refers to what could be achieved if the object of the activity was successfully engaged with the subject. Due to the nature of the classroom (activity system), the subject (teachers) of the system was meant to engage with the object (learners' learning) to achieve the desired outcomes which was successful learning of mathematics. Although the teachers showed some awareness of how children learn and the requirements for formative assessment, they do struggle to enact formative assessment in mathematics. My conclusions from the identified tensions, which arose, and which are captured in the findings of the study, is that the regulatory and enforced compliance of the curriculum have become 'prisons' for teachers; it could arguably be described as the origin of some of the tensions and contestations in the formative assessment practices of teachers.

Another important contribution was to teacher education programme and qualification design where teacher education providers need to include formative assessment in the curricula design and development both at programme and module level design for foundation phase teachers. This study illuminated the contestations and contradictions, which debilitated the "expansion of learning" (Engeström, 1987, 1996) in the activity system of formative assessment in Grade 3 mathematics teaching. Often tensions give rise to solutions of problems, which is why I argue that the contribution of the study is that it could address policy review of both pre-service and in-service teacher education. The study highlighted that initial teacher training did not equip the participating teachers adequately on the role, function, practice and significance of assessment for learning. The study also contributes by recommending strategies to policy makers and curriculum designers and planners on the need to integrate formative assessment in a balanced way focusing on assessment for learning to enhance the quality of teaching and learning.

A third contribution of the study has to do with the implications for teachers' practice. This study was borne out of a concern that many teachers experience difficulties practicing formative assessment. I was therefore interested in exploring teachers' formative assessment practice. While the study findings are limited to teachers in Grade 3, I believe that the case study of Grade 3 teachers can serve as a "living example" (Black & Wiliam, 1998: 17) of an insightful story of practice which has reflective benefit for teachers. The findings of this study were contrary to the literature that indicated that formative assessment was a "quick fix" to learners' learning (Elwood, 2007: 226). This study showed that teachers who attended the AfL programme were not yet competent and confident to enact formative assessment. One of the reasons for teachers' difficulties in enacting formative assessment was that the Grade 3 learners were inexperienced in the AfL strategies since they were not exposed to these in the previous grades. The AfL strategies therefore had to be incrementally integrated into mathematics instruction by all teachers in all grades as an educational norm.

It became evident in the study is that formative assessment is not about the technical application of the AfL techniques as was observed in the lessons of teachers who attended the AfL workshops. Formative assessment is about teachers understanding the purpose of the AfL techniques to be able to operationalise the techniques as pedagogical tools in mediating learning. The study also suggested that the context- specific nature of formative assessment, that the unfolding of formative assessment is dependent upon the context, the school, the district and the subject discipline in which it is practiced. The study showed that the activity system within which teachers teach are likely to be systemic and therefore affects negatively on their ability to enact formative assessment as individual practitioners with their own intuitions and idiosyncrasies; in other words, there is disconnect between components of the activity system such as the dyadic connections, inter dependencies and relationships between teachers (subjects); learners (objects); policies/procedures and frameworks (rules); provincial department, school district (division of labour) and communities (community of practice, parents, training interventions).

In order to create synergy between the activities in the teaching system for the enactment of formative assessment, it is recommended that school districts together with school-based management teams conduct process mapping between all the activities in the activity system. It is further recommended that service level agreements be signed between all the stakeholders (teachers, learners, school management team, district officials, and subject advisors) in order to reify the roles of each stakeholder in the activity system. It is also recommended that school districts implement well thought out change management initiatives, where all stakeholders in the activity system identify their changing roles and how their practices may have to change to keep up with an ever demanding and dynamic activity system within which they operate.

The fourth contribution is to research as the study builds on the body of knowledge on formative assessment. A number of studies on formative assessment practices were analysed through a literature study and trends, patterns, discourses and debates were highlighted and compared. The analyses conducted in this study-highlighted relevance, appropriateness and discords around challenges and successes pertaining to the enactment of formative assessment in school-based classrooms focusing on Grade 3 contexts. The study also contributed to the body of knowledge regarding formative assessment through document analyses pertaining to policies and frameworks regulating and guiding formative assessment in South African public schools. Through the document analyses, I was able to highlight particular gaps, weaknesses and areas that need improvement in order to enhance formative assessment practices by teachers focusing on Grade 3 classrooms.

Finally, this study has a significant methodological contribution. I observed teachers in authentic classroom setting and used activity theory as an analytical tool to study Grade 3 teachers' who tried to enact formative assessment. There has been some research on formative assessment using Engeström's model of ASA (Engeström 2001), however most of these studies (Black & Wiliam, 2006; Crossouard & Pryor, 2008) focused on documenting the implementation of formative assessment collaboratively with teachers and researcher.

To my knowledge, there are limited studies on formative assessment grounded in this theoretical framework within authentic classroom settings, specifically for early grades mathematics teaching. This theoretical lens made it possible to understand the impact of the subjects' motives and the relationship between teacher- learners in the activity. Researchers will be able to replicate this study in existing and new contexts will be easy seeing that the research methodology followed was underpinned by logical, systematic and relevant paradigmatic constructs drawn from current thinkers, researchers and practitioners within the field of assessment in general and formative assessment in particular. Given that, formative assessment practices are context- specific, each additional inquiry will add to our understanding of the existing landscape of formative assessment. This has been a very significant contribution of my study.

5.6. RECOMMENDATIONS

The major recommendation in this study is for teacher development. The study contributes to how continuous professional learning initiatives can be structured, planned and implemented for teachers to improve their practices of formative assessment. In- service teacher training can be expanded and broadened, for not only Grade 3 teachers, but also teachers in other Grades in the foundation phase. The study showed that teachers are competent at assessing a correct answer and correct procedures, which is not what formative assessment is all about.

Formative assessment is about identifying the gaps in learning and is the stepping-stone for teachers to support learners. Teachers experience this as a massive task to assess and teach. It became evident in the study that teachers know about formative assessment, and they talk to formative assessment but for some reason, they find it difficult to implement or enact. Even though they have attended the professional learning programmes, they struggle to take the practice to the classroom. Teachers found it difficult to integrate the AfL strategies with the content of the mathematics subject as the AfL workshop was generic and was not specific to mathematics teaching. Careful attention must go into the content of the professional development.

Teachers will be more likely to engage in the development opportunities if the purpose of the content is obvious and teachers deem the content relevant, applicable and accessible to them (Griffith, Ruan, Stepp, & Kimmel, 2014; Desimone & Stuckey, 2014). Teachers also need to be allowed to learn within the environment of their own contexts (Rohlwing & Spelman, 2014). Teachers need support within their own context of practice, which includes acknowledging their individual beliefs about teaching, their concerns with their current situations, and the lenses with which they are currently viewing the world. It is therefore recommended that the AfL workshops should be subject specific and empower teachers to integrate the techniques with the subject content

The study further suggests that the school district conduct a needs analysis to identify the professional developmental needs/requirements of teachers and offer appropriate training to individual teachers based on teachers' needs. To address the negative training experience and perception of teachers that some of the training interventions were of poor quality, highly theoretical and lacked practical classroom application contexts, it is also recommended that teachers be requested to conduct evaluation of the training interventions. District officials co-coordinating such training interventions can harvest the evaluation feedback or surveys and use these as empirical data to address weaknesses of training intervention initiatives/workshops or work sessions for the sake of improvement.

The study also suggests a review of teacher education for foundation phase teachers. It was evident in the study that teacher's lack of assessment knowledge as well as mathematics content knowledge compromised their ability to enact formative assessment. The adage is that one can only assess effectively if one has the requisite and applied cognitive knowledge of a discipline. In this regard, it is recommended that a task team be set up by the provincial department to engage with higher education institutions to review the foundation phase teacher education programmes and release a "health report" so that the module offerings in the mathematics stream adequately prepares pre-service teachers with both assessment and mathematics content knowledge. Where gaps are identified, it is recommended that provincial departments request higher education institutions to structure training and development interventions for in service teachers to refresh and perhaps reskill their content knowledge background and understanding of mathematics.

Another recommendation emanating from my findings is directed at improving teachers' collaboration and reflection. Collaborative and reflective opportunities are key components to effective professional development (Tillema & Van der Westhuizen, 2006; Shulman & Shulman, 2004). Collaborative opportunities must be natural, not contrived, and be sustained over time. Teachers need to be given time to talk out their issues with peers who share a common ground. However, it should be noted that some teachers may not always respond positively to collaborative opportunities and would welcome a different mode to process the information. This is why reflective opportunities are equally important. The study suggests that school management teams should consider making formative assessment become a whole school commitment across all Grades for the sustained endeavor of the activity. Furthermore, collaborating with other teachers in the department to integrate formative assessment could be a possible suggestion for long- term commitment to formative assessment and to establish a supportive community of practice.

It is further recommended that teachers engaging in formative assessment should design learning experiences that enable teacher reflection on practice. Teachers should be encouraged to reflect in action, on action and after action (Liu, 2015). The literature suggests several benefits of teacher reflection. Successful implementation of formative assessment requires an environment that facilitates collaborative learning. The findings suggest that teachers need to examine their actions during instruction and their relationships with learners.

5.7. LIMITATIONS OF THE STUDY

A main limitation of the study is about the use and generalisability of the findings. This study was a qualitative 'deep dive' study of formative assessment practices occurring during three sequential mathematics lessons with each of the four teachers. Hence, a small sample size was included in this study. I did not describe the critical attributes of formative assessment for all Grade 3 mathematics classrooms. Rather, I provided evidence that confirms what other empirical researchers have found regarding critical attributes of formative assessment practice and I identified attributes for future researchers to investigate.

5.8. MY REFLECTIONS AS A RESEARCHER

My research journey in exploring teachers' formative assessment practices and the time I spent in the Grade 3 teachers' classrooms led me to rethink what it means to become successful at enacting formative assessment practices. Before undertaking this investigation, I viewed the successful practice of formative assessment as contributing to improved learning outcomes. This is still an indicator of successful learning, however, for me the focus has shifted from formative assessment to formative pedagogy. Although all the participants spoke positively of the practice, I observed that all teachers seemed to struggle with the practice of formative assessment. Teachers' struggles emanated from the multifarious needs and complexities of the system, which affected their practice. I have now come to realise that the complexities in the activities of the classroom can become a useful tool that teachers can use to mediate the attainment of learning outcomes in order to improve mathematics learning.

Another professional implication I drew from this study is that the activity of formative assessment is context-specific. My initial understanding of integrating formative assessment into mathematics teaching was that it was about enacting recipe-based techniques. I was of the view that if teachers implemented the formative assessment (AfL) techniques exactly as explained in the literature and the workshops, then the activity would unquestionably lead to improved learning. Through my classroom observations and my interactions with the teachers, I understood that formative assessment techniques could not be rigidly applied, but has to be adapted to match the needs of the learner, the teacher, the school and the community.

Finally, I would be remiss if I did not mention how this study has contributed to my professional development as a researcher and as an academic. As a novice academic and an emerging scholar, this study has contributed significantly to the development of my academic voice. In 2018, I received the excellence award in assessment for the Scholarship of Teaching and Learning at the University of South Africa (Unisa) which is a higher education institution. I demonstrated how I integrated AfL strategies in my teaching to bridge the transactional distance between students and myself at an Open and Distance eLearning Institution. The integration of AfL strategies in my teaching, increased student retention and success rates of students in three modules that I teach.

Finally, the processes I followed from the time I conceptualised this study, to interacting with the participants and the community, and continuously communicating with my most esteemed supervisor, Prof Henning, seemed to generate in me a better understanding of the PHD process. The regular and continuous communications and conversations with my supervisor, the feedback from my committee members and from my peer de-briefers all served as most powerful formative assessment tools in mediating my understanding of formative assessment. These individuals were my pillars of strength and scaffolded my learning all the way throughout my journey.

5.9. CONCLUSION

In this study, the aim was to explore how Grade 3 teachers enact formative assessment in mathematics in a selected district in Gauteng. The study was also aimed at examining what teachers know about formative assessment, their understanding about how learners learn and how teachers use their knowledge of learners' thinking to teach mathematics. Also of concern were teachers' professional development and the district and school management support offered to teachers. The study has shown that although teachers have been to courses and know about formative assessment, they struggle to enact formative assessment in mathematics. It may be because teachers have limited understanding of how learners learn, how learners engage in learning mathematics and therefore their enactment of formative assessment is weak. I conclude that if teachers do not have the skills to enact formative assessment and are limited by all these tensions of the Activity system, then it maybe a cause of why learners are not achieving the outcomes in mathematics. I also conclude that teachers talk to formative assessment but they do not see it as part of children's learning or as part of a process of their own teaching, therefore their enactment of formative assessment is weak. In the South African context, much scholarly work is needed on the conceptualisation and enactment of formative assessment and mathematics in the other grades in the foundation phase. My sense is that such scholarship can assist all teachers' in the foundation phase to enact formative assessment, which will in turn lead to improved classroom practice.

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APPENDIX A

ETHICAL CLEARANCE APPROVAL

NHREC Registration Number REC-110613-036

UNIVERSITY
OF
JOHANNESBURG

ETHICS CLEARANCE

Dear P Govender

Ethical Clearance Number: 2016-093

Case study of grade 3 teacher's formative assessment in mathematics in two urban schools in Gauteng

Ethical clearance for this study is granted subject to the following conditions:

- If there are major revisions to the research proposal based on recommendations from the Faculty Higher Degrees Committee, a new application for ethical clearance must be submitted.
- If the research question changes significantly so as to alter the nature of the study, it remains the duty of the student to submit a new application.
- It remains the student's responsibility to ensure that all ethical forms and documents related to the research are kept in a safe and secure facility and are available on demand.
- Please quote the reference number above in all future communications and documents.

The Faculty of Education Research Ethics Committee has decided to

☒ Grant ethical clearance for the proposed research.
☐ Provisionally grant ethical clearance for the proposed research
☐ Recommend revision and resubmission of the ethical clearance documents

Sincerely,

Prof Geoffrey Lautenbach
Chair: FACULTY OF EDUCATION RESEARCH ETHICS COMMITTEE
22 November 2016

APPENDIX B
GAUTENG DEPARTMENT OF EDUCATION – APPROVAL TO CONDUCT RESEARCH IN SELECTED SCHOOLS IN TSHWANE

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	11 April 2017
Validity of Research Approval:	06 February 2017 – 29 September 2017 2017/66
Name of Researcher:	Govender P
Address of Researcher:	10 Stinkwood Road
	Marlands
	Stinkwood
Telephone Number:	012 429 6828 084 555 7707
Email address:	govenp2@unisa.ac.za
Research Topic:	Grade 3 teachers' formative assessment practices in mathematics in selected schools in Gauteng
Number and type of schools:	Ten Primary Schools
District/s/HQ	Tshwane South District (2 Foundation phase District officials) and Ekurhuleni South

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

The following conditions apply to GDE research. The researcher may proceed with the

11/04/2017

1

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

APPENDIX C
CONSENT LETTER FOR TEACHER PARTICIPANT

FOR ATTENTION: Teacher Participant ………………………..
Informed Consent/Assent Form

Project title: Grade three teachers' formative assessment in mathematics in selected schools in Gauteng.

Investigator: Mrs. Poomoney Govender

Date: 23/01/2017

Please mark the appropriate checkboxes.

I hereby:
☐ Agree to be involved in the above research project as a participant.
☐ Agree that my staff may be involved in the above research project as participants.
☐ I have read the research information sheet pertaining to this research project (or had it explained to me) and I understand the nature of the research and my role in it. I have had the opportunity to ask questions about my involvement in this study. I understand that my personal details (and any identifying data) will be kept strictly confidential. I understand that I may withdraw my consent and participation in this study at any time with no penalty.
☐ Please allow me to review the report prior to publication. I supply my details below for this purpose:
☐ Please allow me to review the report after publication. I supply my details below for this purpose:
☐ I would like to retain a copy of this signed document as proof of the contractual agreement between myself and the researcher

Name of participant: ……………………………………………………

Phone or cell number: ……………………….

Email address: ……………………………………

Signature: ……………………………………….

If applicable:

☐ I willingly provide my consent/assent for using audio recording of my/the participant's contributions.
☐ I willingly provide my consent/assent for using video recording of my/the participant's contributions.
☐ I willingly provide my consent/assent for the use of photographs in this study.

Signature and date: ……………………………………

Signature and date of person taking the consent: …………………………………….

* Vulnerable participants refer to individuals susceptible to exploitation or at risk of being exposed to harm (physical, mental, psychological, emotional and/or spiritual).

Please report any incidents of unethical conduct to geoffl@uj.ac.za.or 0115593016

APPENDIX D
INFORMATION LETTER TO PRINCIPALS OF THE SAMPLE SCHOOL

To: The Principal

…………………….

Gauteng Province

2017/01/23

Re: Invitation to school to participate in the research project

Background to the study

I, Poomoney Govender, under the supervision of Professor Henning from the University of Johannesburg, am doing research on Grade 3 teachers' formative assessment practices in mathematics teaching in selected schools in Gauteng. In this inquiry I want to learn about Grade 3 teachers formative assessment practices in mathematics teaching, specifically how they implement formative assessment as a component of their everyday pedagogical practices. We invite your school to participate in this research study. The study is motivated by the concern that many children in the early Grades and in the last year of the foundation phase struggle to advance in their knowledge of mathematics. In South Africa, the results of the Annual National Assessments have shown through three cycles a significant number of early Grade learners do not reach the expected levels of mathematical competencies.

Procedures involved in the research

I will use a case study design nvolving selected primary schools in Gauteng.Your school has been selected based upon recommendations from the District officials as it is deemed to be information rich. One Grade 3 teacher from your school will be selected based on the number of years of experience. The selected teacher will be invited to an information session at one of the school sites (arranged through the district official)after normal teaching hours, where I will inform them of the purpose of the research and data collection process and the ethical issues involved. Data will be collected through a focus group interview of approximately 90 minutes duration which will be held at a school venue that is convenient to all teacher participants after school hours. The rationale for the focus group interview is to collect data on teachers' understanding, experiences and perception of formative assessment which will guide my selection of four teachers for the purpose of classroom observation. Classroom observation will be used to capture the formative assessment episodes. A total of at least 4 lessons per teacher will be observed. In addition to the selected teachers, the HODs representing the four selected for classroom observation will also be selected.

Potential risks

I am mindful that there may be psychological, emotional or sensational risks arising from the types of probing questions which may lead to stress among teachers. Hence, I will take every precaution and ensure that no mental harm befalls any of the participants. Participants will be informed that their participation in the study is voluntary and that they may withdraw from the study if they do not wish to continue.The children that will feature in the video recordings may be regarded as a vulnerable group, hence I will ensure that the children included in the videos will not suffer any form of mental harm. Furthermore, the children included in the study are not considered as research participants, only the teachers will be considered as research participants as they will be interviewed.

Potential Benefits

The study is intended to contribute to:

a) Knowledge of practice in the selected schools' Grade 3 classes, with this outcome transferable to an audience of researchers.

b) Strategies on formative assessment practices by foundation phase teachers.

c) Case - based study for teacher development programmes

It is further anticipated that the study will provide insight into enhancing mathematics teaching through formative assessment .

Informed Consent

We recognise that participants are not capable of consent unless “informed”. We have, therefore, disclosed the nature of the research, the aims, the duration, the risks and benefits, the nature of interventions throughout the study, compensations where appropriate, researcher details, and details of the ethical review process. Where appropriate, communities, employers, departments and other institutions are also part of the informed consent process.

Confidentiality

Every effort will be made to protect (and guarantee) your confidentiality, identity and privacy. I will not use your name or any information that would allow you to be identified. In addition, all data reported upon will be anonymous and only the researchers will have access to the data that will be securely stored for a maximum of 2 years after publication of my research thesis, reports, or papers. Thereafter, all data collected will be shredded.

Participation and withdrawal

Your participation in this study is voluntary. You may withdraw your consent to participate in the project at any time during the project. If you decide to withdraw, there will be no consequences to you. Your decision whether or not to be part of the study will not affect your continuing access to any services that might be part of this study.

Future interest and feedback

You may contact me (see below) at any time during or after the study for additional information, or if you have questions related to the findings of the study. You may indicate your need to see the findings of the research in the attached consent form.

Govender

Poomoney Govender

APPENDIX E

LETTER TO DISTRICT DIRECTOR IN TSHWANE SOUTH DISTRICT

INFORMATION LETTER: RESEARCH PROJECT

To: The District Director

……………………………….

Date: 2017/01/23

Re: Invitation to school to participate in the research project

Background to the study

I, Poomoney Govender, under the supervision of Professor Henning from the University of Johannesburg, am doing research on Grade 3 teachers' formative assessment practices in mathematics teaching in selected schools in Gauteng. In this inquiry I want to learn about Grade 3 teachers formative assessment practices in mathematics teaching, specifically on how they implement formative assessment as a component of their everyday pedagogical practices. We invite your school to participate in this research study. The study is motivated by the concern that many children in the early Grades and in the last year of the foundation phase struggle to advance in their knowledge of mathematics. In South Africa, the results of the Annual National Assessments have shown through three cycles a significant number of early Grade learners do not reach the expected levels of mathematical competencies.

Procedures involved in the research

I will use a case study design involving selected primary schools in Gauteng.You have been selected based on the recommendations from the District officials. You will be invited to invited to an information session at one of the school sites (arranged through the district official)after normal teaching hours, where I will inform you of the purpose of the research and data collection process and the ethical issues involved.Data will be collected through a focus group interview of approximately 90 minutes duration which will be held at a school venue that is convenient to all teacher participants after school hours. The rationale for the focus group interview is to collect data on teacher's understanding, experiences and perception of formative assessment which will guide my selection of four teachers for the purpose of classroom observation. Classroom observation will be used to capture the formative assessment episodes. A total of at least 4 lessons per teacher will be observed.In addition to the selected teachers, the HODs representing the two selected case study schools will also be selected. I will also seek consent from the parents / guardians of the learners and inform them of their role in the research through an information letter

Potential risks

I am mindful that there may be psychological, emotional or sensational risks arising from the types of probe questions which may lead to stress among teachers, hence I give the assurance that no mental harm will befall any of theparticipants in this study. Furthermore, participants will be informed that their participation in the study is voluntary and that they may withdraw from the study if they do not wish to continue.The children that will feature in the video recordings may be regarded as a vulnerable group and as such I give the assusrance that are not considered as research participants in this study. Only, the teachers are considered as research participants as they will be interviewed.

Potential Benefits

The study is intended to contribute to:

a) Knowledge of practice in the selected schools' Grade 3 classes, with this outcome transferable to an audience of researchers

b) Strategies on formative assessment practices by foundation phase teachers.

c) Case - based study for teacher development programmes

It is further anticipated that the study will provide insight into enhancing mathematics teaching through formative assessment .

Informed Consent

We recognise that participants are not capable of consent unless “informed”. We have, therefore, disclosed the nature of the research, the aims, the duration, the risks and benefits, the nature of interventions throughout the study, compensations where appropriate, researcher details, and details of the ethical review process. Where appropriate, communities, employers, departments and other instances are also part of the informed consent process.

Confidentiality

Every effort will be made to protect (guarantee) your confidentiality and privacy. I will not use your name or any information that would allow you to be identified. In addition, all data collected will be anonymous and only the researchers will have access to the data that will be securely stored for no longer than 2 years after publication of research reports, or papers. Thereafter, all collected data will be destroyed.

Participation and withdrawal

Your participation in this study is voluntary. You may withdraw your consent to participate in the project at any time during the project. If you decide to withdraw, there will be no consequences to you. Your decision whether or not to be part of the study will not affect your continuing access to any services that might be part of this study.

Future interest and feedback

You may contact me (see below) at any time during or after the study for additional information, or if you have questions related to the findings of the study. You may indicate your need to see the findings of the research in the attached consent form.

Govender

Poomoney Govender

APPENDIX F
LETTER SEEKING CONSENT FROM PARENTS

Enquiries: P. Govender
Department of Early Childhood Education
2017/03/27

Dear Parent(s)/ Guardian(s)

I, Poomoney Govender, under the supervision of Professor Henning from the University of Johannesburg, am doing research on Grade 3mathematics teaching in selected schools in Gauteng. In this inquiry, I want to learn about Grade 3 teacher's formative assessment practices in mathematics teaching. The study is motivated by the concern that many children in the early Grades and in the last year of the foundation phase struggle to advance in their knowledge of mathematics. In South Africa, the results of the Annual National Assessments have shown through three cycles a significant number of early Grade learners do not reach the expected levels of mathematical competencies.

Your child's teacher has been identified to participate in the study based on her experience and recommendation by the district official. I will be observing the mathematics lessons taught by the teacher in your child's class. I will gather information for my studies by observing your child's interaction / participation in the lesson; and by looking at your child's written work. This lesson observation will occur over a period of a week starting from the 13 February to 17 February 2017 and will be of approximately one-hour duration per day. In doing so, your child will be involved in the study. I will video record the classroom lessons, which will then be analysed for the study. I would like to request your consent to involve your child in my studies.

Confidentiality

Every effort will be made to protect (guarantee) your child's confidentiality, identity and privacy. I will not use your child's name or any information that would allow your child to be identified. In addition, all data analysed will be anonymous and only the researchers will have access to the data that will be securely stored for no longer than 2 years after publication of research reports, or papers. Thereafter, all collected data will be destroyed. You must, however, be aware that there is always the risk of group or cohort identification in research reports, but your child's personal identity will always remain confidential.

Participation and withdrawal

Your child's participation in this study is voluntary. You may withdraw your consent to participate in the project at any time during the project. If you decide to withdraw, there will be no consequences to you. Your decision whether or not to be part of the study will not affect your continuing access to any services that might be part of this study.Taking part in this study will mostly certainly provide me with rich data, which will help to improve the quality of mathematics teaching. I urge you to discuss this opportunity with your child. Should you agree please sign the letter of consent below?

Your assistance is greatly appreciated.

Govender

Mrs Poomoney Govender
Department of Early Childhood Education
Faculty of Education, University of South Africa

PERMISSION FOR RESEARCH
I,…………………………………………………., the parent / guardian of ………………………, in Grade 3, Herewith grant ☐/ do not grant ☐permission for my child, to be involved in the study on mathematics teaching in the Foundation Phase. I am aware that the lessons will be recorded with the children for further reference. If any research is published, the name and photograph of the participant, as well

as confidentiality, anonymity and privacy of participant will be protected at all times

Signature……………………………….. Date: ……………………………………

APPENDIX G

LEARNER'S INFORMATION LETTER

Date: 2017/02/08

Dear Learner

My name is Teacher Govender and would like to ask you if I can come and watch you do some activities in mathematics with your teacher. I am trying to learn more about how children do activities and learn mathematics with their teachers.

If you agree to do this, I will come and watch you when you are with your teacher doing activities and maths. I will not ask to you to do anything that might hurt you or that you do not want to do. I will also ask your parents if you can take part. If you do not want to take part, it will also be fine with me. Remember, you can say yes or you can say no and no one will be upset if you do not want to take part or even if you change your mind later and want to stop. You can ask any questions that you have now. If you have a question later that you did not think of now, ask me next time I visit your school.

Please speak to mommy or daddy about taking part before you sign this letter. Signing your name at the bottom means that you agree to be in this study. A copy of this letter will be given to your parents.

Regards

Poomoney Govender (Teacher)

Please put a cross in the correct block

Write your name here	**Yes I will take part** 	**No I don't want to take part** 
Date		
Witness		

APPENDIX H
FOCUS GROUP INTERVIEW SCHEDULE

Questions	Detail Probes or Expanders
1. In your own words what is your understanding of learning?	• How do you come to know whether learning has taken place or not? • To what extent is your understanding linked to one or more theories of learning?
2. What do you know about how learners learn?	• What guides your understanding of how children learn? • How did you learn best when you were at school? • What is your role as a teacher in learning? Elaborate on the term “ facilitator” or “ teacher” • How do you engage learners in learning? • What does learner engagement mean to you and how does it relate to learning?
3. Describe the learners in your class and how do you come to understand your learners?	• How do you come to learn about those characteristics? • Do your learners have a good chance of achieving the learning outcomes in mathematics? Why? Alternatively, Why Not? • Which characteristics are critical to your instructional practice and their learning? • Describe a learner who is having great difficulty in your classroom; what do you think are the causes? What are you doing about it? • Describe a learner who is just slightly behind – what do you think is going on? What are you doing about it? • Describe a learner who is really doing well. What do you think is going on? What are you doing about it? • What accounts for the differences between learners who are doing well and not doing well in your class?

4. What strategies do you use to find out what learners know/ do not know when teaching mathematics	• What strategies do you use in class to find out what learners know/ do not know? • What do you do with those learners who have not achieved? • What information do you use to determine whether learners have met the • Elaborate how you decide upon the learning outcomes • You mentioned that learners are diverse, how do you consider those in your teaching and expectations?
5. Explain what informs your planning for the mathematics lessons	• Do you engage in collaborative planning or plan individually? • Are you only informed by policy requirements pertinent to the current Grade? • What informs your decision of what to teach? • How do you use your knowledge of learners thinking in your instruction?
6. Share some of the typical instructional approaches you engage in when teaching mathematics.	• Describe how your classroom activities reflect what you believe about learning.
7. What is your view of engaging learners in learning and what strategies do you use?	• How do you know that your learners are meaningful engaged in learning? • What do you do when you notice your learners are not engaged? • In what ways and under what circumstances are learners engaged with learning on a daily basis.

8. In your own words, share with me your understanding of what is assessment?	• Describe how you approach assessment in your classroom? • What types of assessments do you use? • What is the purpose of assessment? • When if at all, did you first experience formative assessment in teaching mathematics?
9. What informs your assessment practices?	• How have you been trained during your pre-service training to implement assessment? • In your view how useful, are the policy documents in guiding your assessment practices? • How do you plan for assessment?
10. How do you experience the level of district and school based support offered to you.	• Comment on how you experience the in-service professional development trainings offered by the District? • What was your assessment practice before and how has it changed the way you now teach after attending the training? • In what ways has the training improved/ did not improve your teaching? • How do you experience the implementation of your learning from the workshops in your practice? • Comment on the level of support offered by the SMT members.